

Equalize The Histogram Equalization for Image enhancement

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Abstract

Histogram Equalization is one of the technique most commonly used in contrast enhancement. it tends to change the mean brightness of the image to the middle level of the gray level range. However, In this paper, a simple contrast enhancement technique based on conventional histogram equalization algorithm is proposed. This Equalize The histogram equalization technique which takes control over the effect of histogram equalization technique so that it performs the enhancement of an image

without making any loss of details in it. In this method the original input image preserve histogram characteristics, then make histogram equalization method in the other copy image, the output image is compiled with preserve image. so that the loss points in output image can retrieve from input points. It come to reduce the noise in image product process. Experimental results are presented and compared with results from other methods.

1. INTRODUCTION

The goal of image enhancement is to improve the image quality so that image processed is better than the original image for a specific application or set of objectives [1]. Image enhancement is an important area in image processing for both human and computer vision [2]. It is widely used for medical image and as preprocessing step in speech recognition, and many other image video processing applications. Some of these methods make use of simple linear / nonlinear gray level transformation functions.

A very popular technique for contrast enhancement of images is histogram equalization (HE) [3]. It is most commonly used method due to its simplicity and comparatively better performance on almost all type of images. HE performs its operation by remapping the gray levels of

the image based on the probability distribution of the input gray levels .

Many researches have already been done on histogram equalization and many methods have already been proposed. Generally we take two popular methods global histogram equalization and histogram matching.

histogram equalization uses the histogram information of the entire input image for its transformation function. Though this global approach is suitable for overall enhancement, it fails to adapt with local brightness feature of the input images [4]. If there are some gray levels in the input image with very high frequencies, the dominate the other gray levels having lower frequencies. In such situation, GHE remaps the gray levels in such way that the contrast stretching becomes limited in some

dominating gray levels having larger image histogram components and causes significant contrast loss for other small ones. Histogram Specification (also called Histogram matching) is similar in concept to histogram equalization. Histogram Specification (HS) [5] is another method that takes a desired histogram by which the expected output image histogram can be controlled. However specifying the output histogram is not a smooth task as it varies from image to image.

To overcome the aforementioned problems, we have proposed a method in section 3, called Equalize The Histogram Equalization. This method is an enhancement of HE presented in which we get a fast and good result over image when compared to other mentioned methods.

Equalize The Histogram Equalization given results close to the (HS) but, better than it for many images we taken, also it faster, we shall see an (HS) apply HE equations twice, once at the input image histogram bin, second repeat the same equation at desired histogram so that it give a good result but in slow way, thus our method can give nearly result in a short time.

2. HISTOGRAM EQUILIZATION TECHNIQUE

In this section, we review two of the existing HE approach in brief, first we discuss GHE, second we describe, HS.

2.1 GLOBAL HISTOGRAM EQUILIZATION TECHNIQUE GHE

The goal of histogram equalization is to spread out the contrast of a given image evenly throughout the entire available dynamic range, in this case between 0 and 1. In histogram equalization technique, it's the probability density function (PDF) that is

being manipulated. It changes the PDF of a given image into that of a uniform PDF that spreads out from the lowest pixel value (0 in this case) to the highest pixel value (L-1). This can be achieved quite easily if the PDF is a continuous function. However, since we are dealing with a digital image, PDF will be a discrete function. Let suppose we have an image x , and let the dynamic range for the intensity r_k varies from 0 (black) to L-1 (white)[2]. This PDF can be approximated using the probability based on the histogram $p(r_k)$ as follows:

$$pdf(x) = p(r_k) = \frac{\text{total pixel with intensity } r_k}{\text{total in image } x} \quad \text{Eq.(1)}$$

From this PDF, we can then obtain the cumulative density function (CDF) as follows:

$$cdf(x) = \sum_{k=0}^{L-1} p(r_k) \quad \text{Eq.(2)}$$

Where $p(r_k)$ is the probability for pixel of density r_k .

To get the value of the pixel, $p(s_k)$ need to be multiplied by L-1 and then round it to the nearest integer.

$$s_k = (L-1) \sum_{k=0}^{L-1} p(r_k) \quad \text{Eq.(3)}$$

In practice, the result in undesirable effects where intensity level with high probabilities often become over-enhanced and the levels with low probabilities get less enhanced, their number reduced, or even eliminated in the resulted image.

2.2 HISTOGRAM SPECIFICATION TECHNIQUE HS

Histogram Specification (histogram matching) is an extension to the HE. In

histogram equalization technique, we are trying to achieve that is the output histogram should follow the uniform PDF. However for histogram matching, we want the output histogram to follow according to that we specify. To achieve this, first histogram equalize the input image, then the PDF of this resulting equalize image will be matched to the PDF of desired histogram[4]. Let r and s be the pixel values for the input and equalized images respectively, and let z be the pixel value for the desired histogram. First, the given image would be histogram equalized using HE technique discussed previously. However, at this level the computation is only to finding $p(s_k)$, i.e. the actual pixel value will be done at the end of the process. Next, the CDF of the desired histogram i.e. $p(z_k)$ is computed[3]. Finally, for every $p(s_k)$, the nearest $p(z_k)$ is sought. The corresponding s_k then is multiplied by $L-1$ to get the actual output value.

The rest Eq. is as follows:

$$p(s_k) = s / L - 1 \quad \text{Eq.(4)}$$

$$p(z_k) = \sum_{k=0}^{L-1} s_k \quad \text{Eq.(5)}$$

$$s_k = \text{round}(\text{nearest value for } p(z_k)) \quad \text{Eq.(6)}$$

3. Equalize The Histogram Equalization EHE

The proposed method, preserve image from source image at the second copy we apply HE exactly, then we add two image the output image with preserve input image, go back to equation 1,2 and 3 to illustrate our method:

$$pdf(x) = p(r_k) = \frac{\text{total pixel with intensity } r_k}{\text{total in image } x} \quad \text{Eq.(1)}$$

$$cdf(x) = \sum_{k=0}^{L-1} p(r_k) \quad \text{Eq.(2)}$$

$$s_k = (L-1) \sum_{k=0}^{L-1} p(r_k) \quad \text{Eq.(3)}$$

$$m = s_k + r_k \quad \text{Eq.(4)}$$

Where r_k is the source image pixel .

to illustrate the concept above, consider the following example with 4X4 matrix of a 3-bit image.

1	1	1	5
0	0	0	4
0	3	3	3
4	2	2	7

Fig (1) 4X4 matrix of a 3-bit image

The histogram of this image is given as follow:

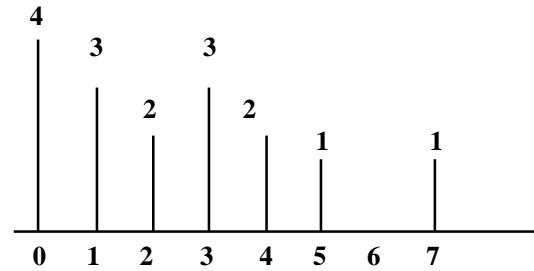


Fig (2) histogram of image

The PDF for this image can be computed simply by taking the histogram above and divided by the number of pixel, i.e.

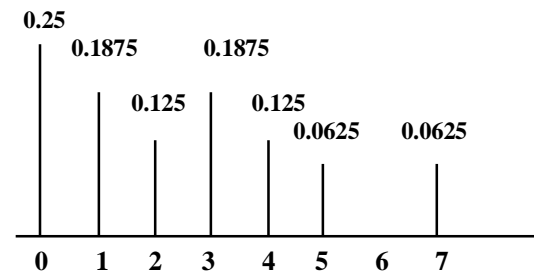


Fig (3) PDF of image

The CDF of this image is then computed as an accumulated of the above histogram, thus using Eq.(2) we obtain the following CDF and the corresponding $p(s_k)$ sequence showing in the following table:

r	$p(r_k)$	$p(s_k)$	s	m
0	0.25	0.25	2	2
1	0.1875	0.4375	4	5
2	0.125	0.5625	5	7
3	0.1875	0.75	6	9
4	0.125	0.8750	7	11
5	0.0625	0.9375	8	13
6	0	0.9375	8	14
7	0.0625	1	8	15

Table(1) r , $p(r_k)$, $p(s_k)$, s and m values
Thus for higher intensity pixel (Wight or black) we can reduce them by return to original pixel image but, after adding with the result of HE, We can illustrate whole steps by this algorithm:

```

1- start
2- read image(a)
3- r=a
4- (n,k)=size(a);L=n*k
5- num=number of times for each pixel
6- pdf=num/(L-1)
7- cdf=sum(pdf)
8- s=sum((L-1)*cdf)
8- m=s+r
9- end

```

Algorithm of EHE method
the algorithm above is converted to matlab code, we written three function in matlab :
1- hispin(x) for Equalize the histogram equalization method.
2- hismatch(x) for Histogram matching method.
3- histrslt(r1) for comparison between the three methods.

The histeq command made HE method in matlab, These functions are explain in appendix A

we use a gray-scale images at various type jpg, png, gif, bmp.

4. EXPERIMENTAL RESULTS

There are two factors to measure the noise in image first is the PSNR second is ASNR, The PSNR is most commonly used as a measure of quality of reconstruction of loss compression codes (e.g., for image compression). Also use to observe the quality of zoomed images(6).

ASNR (Average Signal to Noise Ratio) is commonly used to measure in image enhancement applications, which is given by

$$\text{ASNR} = (\mathbf{f} - \mathbf{b})/\sigma \quad \text{Eq.(7)}$$

Where f is the average gray-level value of the enhanced image.

b is mean gray-level value of the original image.

σ is the standard deviation.

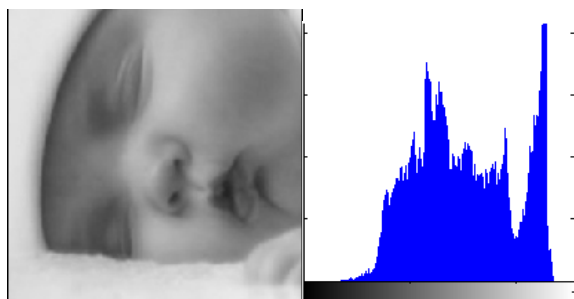
If the ASNR value is larger, the enhancement method perform better, in table(2) shows the increased ASNR values from HE to HS to EHE methods for the baby image.

Methods	ASNR value
Histogram Equalization	0.5223
Histogram matching	3.2269
Equalize The Histogram Equalization	3.9879

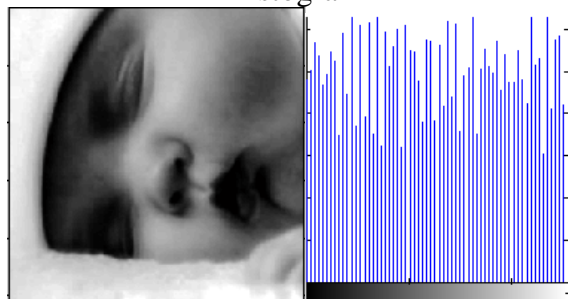
Table(2) ASNR of HE,HS and EHE methods which applied at the baby image.

The result from previous technique and the proposed technique are compared with the enhancement ability of this proposed method using ASNR values on variety of

images. Here we show some of the results. In fig(4-b) HE image shows that the average brightness has increased instead of increasing the contrast, In fig(4-c) HS image shows low brightness, In fig(4-d) EHE image shows the image is nearly to image fig(4-c) middle brightness and its ASNR is better.



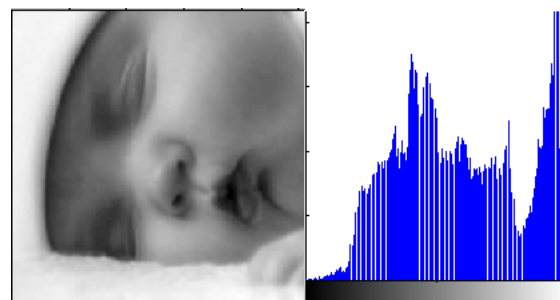
(a) Original Gray Scale Image and its Histogram



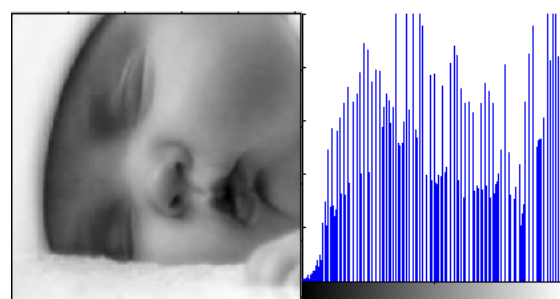
(b) Result of HE & its histogram

5. CONCLUSION

We have proposed a simple and efficient approach for image enhancement of low contrast image. EHE enhances image without making any loss in image details. this method is simple and computationally effective that makes it easy to implement and fast, by use the same steps of algorithm of HE and compiled the output image with the original image, and overcome at the repetition the same steps which applied in HS algorithm.



(c) Result of HS & its histogram



(d) Result of EHE & its histogram

Fig(4) examples of enhancement images

To obtain a more confidence results we take several images and apply our algorithm. We take from these several five images and apply HE and EHE as shown in appendix B at Fig(5). So we can see by eyes first and by ASNR second (as shown in table(3)) the EHE give more enhancement images.

6. REFERENCES

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enhancement,” IEEE Trans. Medical Imaging, pp. 304–312, 1988.

[4] R. C. Gonzalez, R. E. Woods, Digital image processing. 2nd ed. Reading, MA. Addison-Wesley, 1992, pp. 85-103.

[5] J. Y. Kim, L.-S. Kim, and S. -H. Hwang, “An advanced contrast enhancement using partially overlapped sub-block histogram equalization,” IEEE Transactions on Circuits and Systems for Video Technology, Vol.11, pp. 475 –484, 2001.

[6]

http://en.wikipedia.org/wiki/Peak_signal-to-noise_ratio

الخلاصة

طريقة تعديل المخطط التقليدية لعمل تحسين الصورة بدون فقدان لاية تفاصيل للصورة. في هذه الطريقة تم الاحتفاظ بصفتان المخطط للصورة الاصلية ومن ثم اجراء عملية تعديل المخطط على النسخة الثانية بعدها تدمج الصورة المخرجة مع الصورة الاصلية، كي يتم استرجاع النقاط المفقودة في الصورة المخرجة. وجاءت هذه الطريقة لتقليل الضوضاء في عملية انتاج الصورة. هنالك نتائج عملية مدعمة ومقارنة مع نتائج الطرق السابقة.

أن طريقة تعديل المخطط (المدرج التكراري) للصورة صمم ليكون طريقة سهلة لتحسين التباين في الصورة. في أية حالة فإنه يميل الى تعديل متوسط السطوع للصورة الى النصف من مديات المستوى الرمادي. في هذا البحث صممت طريقة بسيطة لتحسين التباين بالاعتماد على خوارزمية تعديل المخطط . وهي تعديل طريقة تعديل المخطط والتي تأخذ قوة

APPENDIX A

1-EHE matlab program

```
function[rslt4,rslt1,f,s,h]=hispin(x)
[n,m]=size(x);h=n*m;
q=reshape(x,1,h); [tmp,ind]=sort(q);
rt2=0:255;
[numTimesInMatrix, Number] =
hist(x(:,rt2);
rslt1=numTimesInMatrix;
siz=length(unique(tmp))+1;
y=numTimesInMatrix;
% prk = pdf of x
prk=rslt1/h;
% psk =cdf of x
psk(1)=prk(1); ps=prk(1);
for i=2:length(rslt1);
    ps=ps+prk(i);
    psk(i)=ps;
end;
s(1)=round(prk(1)*255);bs=s(1);
for i=2:length(rslt1);
```

```
bs=bs+255*prk(i);
s(i)=round(bs);
end;
t=1;
for i=1:length(rslt1);
    for j=1:y(i);
        outimg(ind(t))=s(i);
        t=t+1;
    end;
end;
rslt4=reshape(outimg,n,m);
rslt4=mat2gray(rslt4);
f=rslt4+double(x);
f=mat2gray(f);
```

2-HS matlab program

```
function [rslt]=hismatch(x)
[rslt4,rslt1,f,s,h]=hispin(x)
bs=s/h; rt2=0:255;
pzk(1)=bs(1); ss=bs(1);
```

```

for i=2:length(rslt1);
    ss=ss+bs(i);
    pzk(i)=ss;
end;
rslt3=pzk;
z(length(pzk))=rt2(end);
for i=1:length(pzk)-1;
    if (abs(psk(i)-pzk(i))< abs(psk(i)-
pzk(i+1)));
        z(i)=rt2(i);
    else
        z(i)=rt2(i+1);
    end;
end;
t=1;
for i=1:length(rslt1);
    for j=1:y(i);
        outimg(ind(t))=z(i);
        t=t+1;
    end;
end;
t=1;
for i=1:length(z);
    for j=1:y(i);
        img(ind(t))=(z(i)+tmp(i))/2;

```

```

        t=t+1;
    end;
end;
rslt=reshape(outimg,n,m);
rslt=mat2gray(rslt);


---

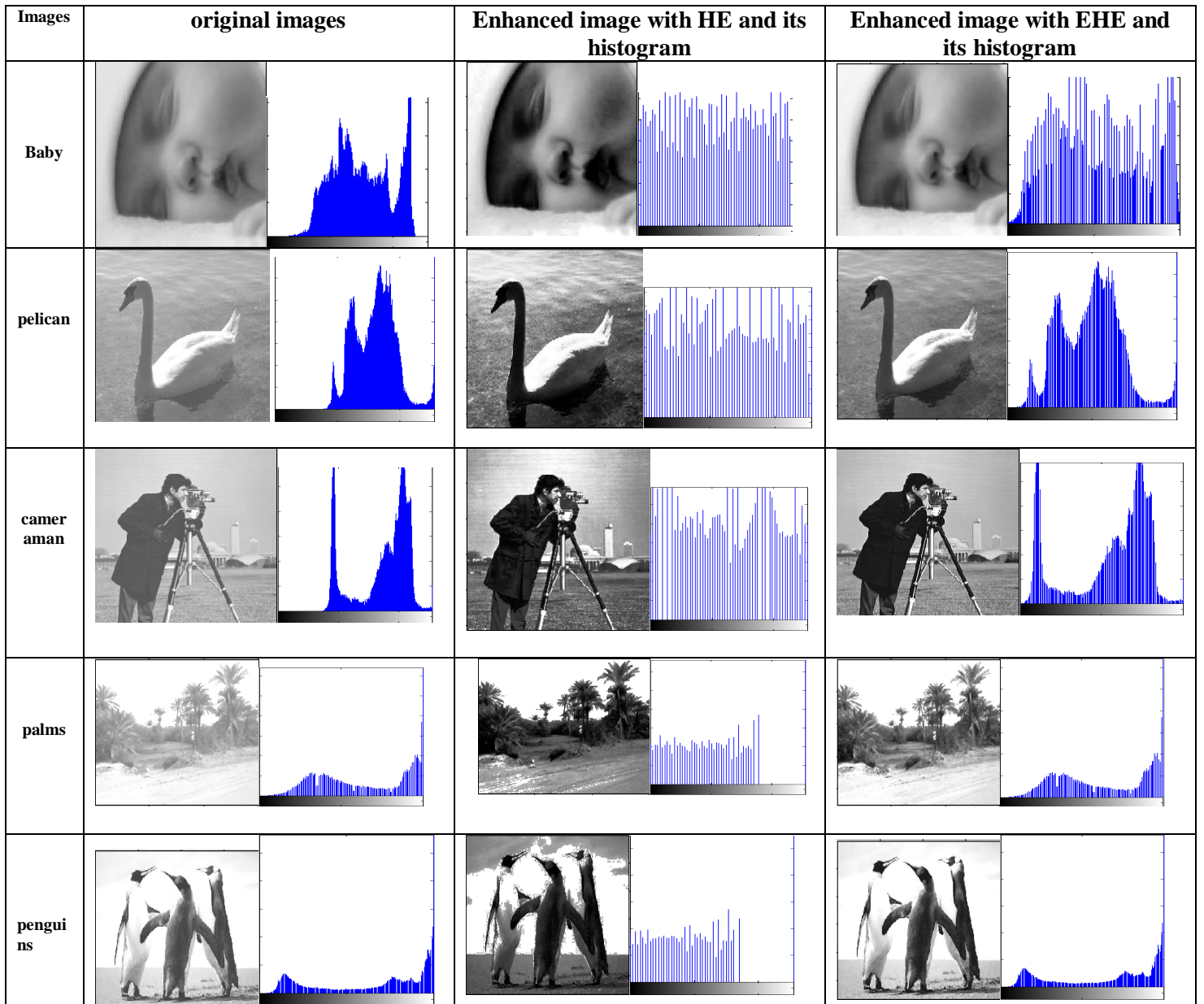

3- comparison matlab program
function histrslt(r1)
r1=rgb2gray(r1);
[rslt4,rslt1,f,s,h]=hispin(r1)
[rslt]=hismatch(r1);
J = histeq(r1);
figure,subplot(1,2,1),imshow(r1);
title('source img');
subplot(1,2,2),imhist(r1);
figure,subplot(1,2,1),imshow(j)
title('HE img');
subplot(1,2,2),imhist(J);
figure,subplot(1,2,1),imshow(rslt)
title('HS img');
subplot(1,2,2),imhist(rslt);
figure,subplot(1,2,1),imshow(f)
title('EHE img');
subplot(1,2,2),imhist(f);


---



```

PENDIX B



Fig(5) some results of gray-scale images enhancement by HE and EHE

Table(3) ASNR comparison of the enhancement images using HE, HS and EHE

Images	methods		
	HE	HS	EHE
Baby	0.5223	3.2269	3.9879
pelican	0.9642	4.5726	4.5766
cameraman	0.9487	3.6525	3.6525
palms	1.8482	5.1241	5.1242
penguins	0.9699	3.1256	3.1257