International Conference on Innovative Trends in Electronics Communication and Applications 2015 [ICIECA 2015]

ISBN	978-81-929742-6-2
Website	icieca.in
Received	02 - April - 2015
Article ID	ICIECA015

VOL	01
eMail	icieca@asdf.res.in
Accepted	15 - November - 2015
eAID	ICIECA.2015.015

Image Enhancement Using Affine Histogram Equalization Model

J Kanimozhi[1], P Vasuki[1], K G Sowmiyadevi[1], S Padma[1], G L Vijayalakshmi[1]
[1]ECE Department, K.L.N College of Information Technology

Abstract: *Colour image enhancement is complex and challenging task in digital imagery. Preserving the hue of the input image crucial in a wide range of situations. This work aims to develop hue and range (gamut) preservation techniques. The proposed method consists of two stages via range preserving in optimal way enhancement, scaling and shifting colour enhancement. First stage preserves hue in a colour image by the identified affine histogram equalizations method. Second stage preserves the range (gamut)(0 - 1) by scaling and shifting algorithms. The result is compared with the existing method of histogram specification produces the better result.*

Keywords*:* Colour image enhancement, range preserving, scaling and shifting, histogram equalization, histogram specification.

INTRODUCTION

Image enhancement is used to enhance the standard of an image for visual recognition of human beings. It is also used for small grade optics utilization. It is a task in which the set of pixel values of one image is modified to a new set of pixel values so that the new image formed is visually pleasing and is also more suitable for a scrutiny. The main approach for image enhancement such as contrast stretching, slicing, histogram equalization, for grey scale images are discussed in many books. The generalization of these approaches to colour images is not straight forward. Unlike grey scale images, there are some elements in colour images like hue, which need to be properly handled for enhancement.[1] Hue, saturation and intensity are the characteristics of colour. Hue is that characteristic of a colour which decides what kind of colour it is, i.e., a red or an orange. In the spectrum each colour is at the maximum purity (or strength or richness) that the eye can acknowledge, and the spectrum of colours is narrated as fully drenched. If a drenched colour is diluted by being blended with other colours or with white light, its intensity or saturation is decreased. For the purpose of enhancing a colour image, it is to be seen that hue should not alter for any pixel. If hue is changed then the colour gets changed, thereby deforming the image [2].

To enhance the ocular quality of an image without deforming it for image enhancement. Several algorithms are accessible for contrast enhancement in grey scale images, which change the grey values of pixels depending on the criteria for enhancement.

This paper helps to the enormous development in digital colour imaging and display technology. In spite of the major amount of research, colour recognition and colour aspects are still open problems. The demand for fast efficient algorithms improving the colour content of digital images has increased dramatically. The applications of colour image improvement are abundant. They concern for example digital cameras and mobile phone cameras, medical imaging, post-production industry, video reconstruction of old pictures and movies.

Histogram specifications are used in previous methods. Exact histogram specification (HS), which is also known as histogram matching, of single-valued (grey valued) images desire to transform an input image to an output image which exactly fits a prescribed target histogram. Histogram equalization (HE) is a particular instance of HS where the target histogram is uniform. We do not

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

emphasis on the construction of target histograms. Instead, we adopt a simple approach inspired by [4]. For digital image HS is an ill posed problem [5]. The hint to ensuring exact HS is to obtain a *meaningful total strict arrangement* of all pixels in the input digital image. We perform exact HS using the algorithm in [2] which currently provides the best pixel ordering in terms of standard and speed. We perform Recursive Mean Separate Histogram Equalization (RMSHE) using the algorithm in [4]

The extension of histogram methods to colour images is a quite difficult task. The histogram of a gray-value image is single dimensional (1D) while the histogram of a colour image is three dimensional which gives rise to an under-determined problem. For instance, applying HS to each colour channel separately changes the colour content (the hue) of the image. Further it is not easy to produce a colour images that obeys the range constraints. As a central outcome of this paper, we propose a general and optimal hue and range conserving colour allotment methodology [6].

In this paper we deserve to design colour image enhancement methods in the RGB space sharing three important features, namely hue and range (gamut) conservation and low calculation complexity. The hue describes in each area of an image the main colour ingredient that one really recognizes, e.g., red, orange, magenta, yellow and so on .The hue has the nice property of being same under variation of direction and intensity of the incident light [3]. Thus, by preserving the hue and enhancing the brightness, the acquired image will appear more colourful. Normally colour image enhancement consist of two main problems which are Hue preservation, Gamut problem

A colour may displayed on your monitor in RGB may not be printable in the gamut of your cmyk printer. For example a pure red colour only expressed in RGB colour space, that cannot expressed in cmyk colour space.
This is gamut problem. The gamut problem occurred in an enhanced image is rectified by three simple algorithms. This paper proposes three main algorithms which are range preserving in optimal way enhancement,
scaling colour enhancement, shifting colour enhancement

In this paper histogram based methods are selected according to the applications will be effective but selection of fast algorithm will be more efficient. Fast Algorithm is performed by the following steps. Intensity channel of the input RGB image is matched to a particular histogram which gives us the target intensity image.

The RGB colour values are computed based on the target colour space, some methods work directly in the RGB space intensity image so that they satisfy the hue and gamut while others operate in transformed colour spaces. e.g., LHS, constraints in an optimal way. These stages are briefly discussed below.

PROPOSED METHODOLOGY

Histogram equalization is a process of automatically determining the transfer function which produces an output image with a uniform histogram. But histogram equalization is not suitable for some application. In such case, the histogram shape of the output image may be specified. The method used to generate a processed image that has a specified histogram is called histogram matching or histogram specification.
The intensity of a original image W can be defined as

$$f = (1/3)\ (Wr+Wg+Wb) \quad (1)$$

where f is a intensity of the image; Wr,Wg,Wb are intensity of rgb colour;

Similarly from the histogram matched image W1 we can find the intensity as

$$f1 = (1/3)\ (W1(r)+W1(g)+W1(b)) \quad (2)$$

where f1 is the intensity of the histogram matched image

In general Affine mapping is defined by

$$W1 = aW + b \quad (3)$$

The equation can be modified for all the RGB components as

$$W1c(x) = a[x]\ W[x] + b[x] \text{ for } c\epsilon\ (r,g,b) \quad (4)$$

Use the intensity of the channels are weights of the R,G,B Channel. To find f^ which is the target intensity of the specified Histogram. its gray value ranges from (0- L-1). The histogram Function does not involve a strict ordering of 'f' which is the Intensity of the original image and f^ is not uniform. This Produces some artifacts…this can be solved by histogram Specification using strict ordering.

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

For intensity fit the equation (2) should be satisfied .this happens if and only if when equation (4) can be modified such that

$$f1[x] = a[x]f[x] + b[x] \quad (5)$$

from equation (5)

$$b[x]=f1[x]-a[x]f[x] \quad (6)$$

sub in equation (4)

$$W1c[x] = a[x] (Wc[x]-f[x]) + f1[x] \text{ for } c\epsilon\ (r,g,b) \quad (7)$$

By Naik & Murthy algorithm

$$a[x]=(f1[x]/f[x]) \text{ for scaling case(a)}$$

There are two cases by equation (4)

Scaling: for $b[x] = 0$, equation (7) can be modified as

$$W1c[x]= = (f1[x]/f\ [x])Wc[x]$$

For c (r,g,b) (8)

Shifting: for $a[x] = 1$, equation (7) can be modified as

$$W1c[x] =Wc[x]-f[x] +f1[x] \quad (9)$$

These equations are then used for preserving the range, we will use for all x € Xn the magnitudes

$$M[x] = \max\ \{Wc[x]: c\ (r, g,b)\}$$

$$m[x] = \min\ \{Wc[x]: c\epsilon(r,g,b)\} \quad (10)$$

Where M[x] is the maximum and m[x] is the minimum of the RGB components

From algorithm 1, intensity of the original image and the target intensity are computed. The aim is that image has same intensity as target intensity and the hue of the target image and original image is to be matched. The ranges between $0\leq\varpi c\leq L-1$, c{r,g,b}.

First the histogram equalization is applied to the colour image. From the result of histogram equalization of input image it is clear that the histogram is not uniform and its pixel values spread over the entire image. Then the histogram specification is applied to the original image. Here the histogram is uniformly distributed. But the output image of histogram specification consists of problem. The problems occurred in the previous work can be overcome by simple algorithms known as affine histogram equalization model. The model has two simple algorithms. Range preserving in optimal way enhancement, Scaling and Shifting colour enhancement

Here the histogram of the original image having pixels which are not in order once if user want to enhance the input image , should go algorithm 1 after the strict ordering which magnify the dark and bright pixels after that it will be enhanced by using scaling and shifting algorithm. The Following there main algorithms which we have proposed to rectify the hue and gamut problem. The algorithm provided here is the best way to rectify hue. Affine mapping to all pixels for the desired stretching of he gamut problem in [2]. Incase [2] f [i] / f1[i] >> 1 range constraints are not guaranteed. To overcome the problem by switching RGB colour space to CMY colour space and then to transform back to RGB space. This step reads for all c{r,g,b}. This algorithm often used to avoid the range problems. The optimum and gamut problem which are occurred generally in when making image enhancement. the algorithm 2 naik and murthy algorithm gives only gray scale enhancement ,here this paper image enhancement using affine histogram equalization model gives colour image enhancement yet this paper is also suitable for making large size image enhancement and it is assist to tremendous progress in digital colour imaging and display technology. Range preservation in optimal way enhancement:

The gamut problem was removed in a optimal way and the pixel values chosen are closest in the range. This algorithm is a convex combination of scaling and shifting.

AFFINE ALGORITHM TO PRESERVE RANGE

Preserving range is a important parameter. This model is the convex combination of scaling and shifting for $T \in [0,1]$The simplest hue and range preserving method is to apply the range for these components is

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

$0\ m[x] \leq f(x) \leq M(x)\ L-1$ (11)

Two types of gamut problem occurs, when maximum of RGB component exceed the range, there occurs upper gamut problem. i.e. L-1

Then M[x] = W1s[x] for s(r, g, b)

For that the best correction of this is to choose pixel values is clearly to choose a[x] in equation (7)

So that the closest value in the range i.e. W1s[x] = L-1 from (11) so

$L-1=a[x]\ (Wc[x]-f[x]) + f1[x]$ (12)

From (11) for non gray valued pixels

$M[x]-f[x] > 0$ so that

$a[x] = \{(L-1-f1[x])/(M[x]-f[x])\} \geq 0$

Thus for the upper gamut problem the corrected colour values of pixel x is

$W1c[x]= \{(L-1-f1[x])/(M[x]-f[x])\}(Wc[x]-f[x]+f1[x] \text{for } c\epsilon(r,g,b)$ (13) When minimum component $m1[x] < 0$ then lower gamut problem is occurred. For s (r,g,b) be such that

W1s[x] = m1[x] so that the best correction is W1s[x] = 0,

$0=a[x]\ (m[x]-f[x])+ f1[x]$ (14)

From (11) for non gray valued pixels $f[x] - m[x] > 0$ so that

$a[x] = \{f1[x]/\ (f[x] - m[x])\}\quad 0$

So for the lower gamut problem the corrected colour value is given as

$W1c[x] = \{f1[x]/\ (f[x] - m[x])\}\ (Wc[x]-f[x])+ f1[x]$ for c (r,g,b) (15)

This model is the convex combination of scaling and shifting for T [0,1] So combining equation (8) and (9) we get

$W1c[x] =T\ (f1[x]/f[x]) + (1-T)\ (Wc[x]-f[x]) + f1[x]$

$=a[x](Wc[x]-f[x])+f1[x]$ (16)

$a[x]=T(f1[x]/f[x])+(1-T)$ (17)

We propose a general affine model for image enhancement using affine HS model in the RGB space which gives rise to Algorithm 3. Two simple but key instances of this algorithm are the Multiplicative algorithm 4 and the Additive algorithm 5. We show how the result of Algorithm 3 can be faithfully approximated as a convex mixture of the images obtained by Algorithm 4 and Algorithm 5, which is quite practical. The enhancement performances of our algorithms and the Naik-Murthy algorithm [2] are analyzed in terms of their chromaticity improvement. In all cases, our algorithms clearly exceed the algorithm in [1] recently applied to colour images in [7]. All numerical tests confirm our theoretical outcomes. Our algorithms are simple and fast. They are really efficient when one wishes to give a better clarity of images (not too altered by artifacts) while preserving the original colour ambience.

SCALING AND SHIFTING ALGORITHMS

For T [0,1] the above algorithm yields scaling and shifting algorithms. Observed that from equation (8) , (9) ,(12) and (14)

$R0m[x] = (m[x]-f[x]) + f1[x]$ (18)

$R0M[x] = (M[x]-f[x]) + f1[x]$ (19)

$R1M[x] = (f1[x]/f[x])\ M[x]$ (20)

EXISTING ALGORITHMS I & II:

Algorithm I: (Exact Histogram Specification)

Initialization:

u(0)=3f,(β,α):=(0.1, 0.05), and target histogram bh= (bh1, . . ., bhL). Choose K (e.g., K = 6).

For k = 1, . . . ,K compute

3. u(k) = f − η−1(βGTη(Gu(k−1)).

Where η(t) :=t/α + |t| and η−1(y) =αy/1 − |y| and G is a forward difference matrix.

Order the values in according to the corresponding ascending entries of u(K).

HS step: divide the obtained ordered list of indices into L groups and assign gray value 0 to the first bh1 pixels and so on until gray value L − 1 to the last bhL pixels. This provides the target intensity b f. The affine model (8) obeys (a) if and only if

W^c[i] = a[i](wc[i] − f[i]) + f^[i], c {r, g, b}

This algorithm is used to make the pixels strict ordering.

Algorithm II*:* (Naik and Murthy [2])

Compute the intensity f of w and the target intensity b f.

For i in compute

w^c[i] :=(f^[i]/f[i])wc[i] if f[i]/f[i] ≤ 1

w^c[i] :=L − 1 − f^[i]/L − 1 − f[i](wc[i]−f[i]) + f^ [i] if f^ [i]/f[i]>1

Algorithm III: (Range Preserving in Optimal Way enhancement)

Compute the intensity f of W by (1) and the target intensity f1 using histogram matching.

For x Xn compute M[x] and m[x] by 10.if f[x] = 0,

ThenW1[x] = 0.otherwise compute

a[x] = T (f1[x]/f[x])+(1-T)

RTm[x] = a[x] (m[x]-f[x]) + f1[x] (21)

RTM[x] =a[x] (M[x]-f[x]) + f1[x] (22)

For all c (r,g,b):cases

W1c[x]=a[x](Wc[x]-f[x])+ f1[x] if RTm[x]≥ 0 and RTM[x]≤L-1

W1c[x]={(L-1-f1[x])/(M[x]-f[x])} (Wc[x]-f[x]) + f1[x] if RTM[x] >L-1

W1c[x]={f1[x]/(f[x]-m[x])} (Wc[x]-f[x]) + f1[x] if RTm[x]<0

The simplest hue range preserving process is to exert the affine mapping to all pixels. By finding the least and largest pixel values compute the average value for all Pixels. It is the desired stretching of pixels. When intensity values are not matched for the original and target, range is not guaranteed .For this cases the solution is to switch from RGB colour space to CMY space and then transform it back to RGB.

The main objective of affine specification model is the intensities of original and target images are to be matched, hue of original and target images are to be coincide, range is in between 0 to L-1.

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

The range is exceeded (L-1) there is occurrence of upper gamut problem. The range is less than 0 there is occurrence of lower gamut problem. These Problems solved in an optimal way doing some pixel correction.

Algorithm IV: (scaling Colour Enhancement)

This algorithm is applied when T = 1.

Compute the intensity f of W by (1) and the target intensity f1 using histogram matching.

For x Xn compute M[x] by10.

if f[x] = 0, then W1[x] = 0.

Otherwise compute

$$R1M[x] = (f1[x]/f[x])M[x] \text{ and for all c } (r,g,b) \quad (23)$$

CASES:

$$W1c[x] = = (f1[x]/f[x])Wc[x] \quad (24)$$

if RTM[x]≤L-1

$$W1c[x] = \{(L-1-f1[x])/(M[x]-f[x])\} (Wc[x]-f[x]) + f1[x] \text{ if } RTM[x] > L-1 \quad (25)$$

Optimal range preserving algorithm yields two simple scaling and shifting algorithms called additive and multiplicative algorithm. The scaling parameter varies between (0-1). When this parameter is 0 then apply the shifting algorithm. When this is 1 then apply the scaling algorithm

Algorithm V: (Shifting Colour Enhancement)

This algorithm is applied when T = 0.

compute the intensity f of W by (1) and the target intensity f1 using histogram matching.

For x Xn compute M[x] and m[x] by 10.if f[x] = 0,

Then W1[x] = 0.otherwise compute

$$RTm[x] = a[x] (m[x]-f[x]) + f1[x] \quad (26)$$

$$RTM[x] =a[x] (M[x]-f[x]) + f1[x] \quad (27)$$

For all c (r,g,b):cases

$$W1c[x] = a[x] (Wc[x]-f[x]) + f1[x] \quad \text{if } R0m[x] \geq 0 \text{ and } RTM[x] \leq L-1 \quad (28)$$

$$W1c[x] = \{(L-1-f1[x])/(M[x]-f[x])\} (Wc[x]-f[x]) + f1[x] \quad \text{if } R0M[x] > L-1 \quad (29)$$

$$W1c[x] = \{f1[x]/ (f[x] - m[x])\} (Wc[x]-f[x]) + f1[x] \quad \text{if } R0m[x] < 0 \quad (30)$$

Instead of applying our Affine Algorithm III for some λ [0, 1], we can compute the images bw+ by the Shifting Algorithm V and bw× by the Scaling Algorithm IV and build their convex combination for the same λ [0,1].Our conclusions the scaling colour enhancement algorithm gives the most colourful image. the shifting algorithm yields colour values between those of the scaling and the naik-murthy; it performs better than the last one.

RESULTS AND DISCUSSION

More than 250 images are taken to test the method including Image Database such as CSIQ, Tid 2008, holiday images etc., Three algorithms such as optimal and range preserving, if the range is T=0 then shifting algorithm is applied and if the range is T=1 then scaling algorithm is applied to images after histogram specification and histogram equalization and performance metrics for the images monument.jpg,roping.jpg,1600.jpg,family.jpg, fisher.jpg are shown in Tables 1-4.Table

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

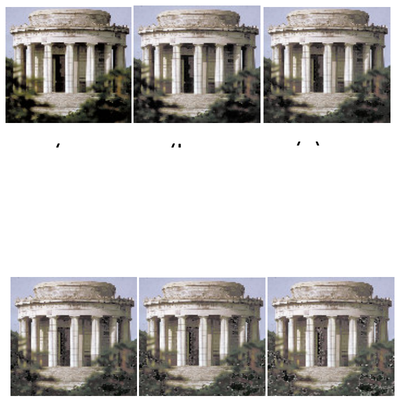


Fig.1. Output of Range preserving in optimal way enhancement using histogram specification .(a)) input image,(b)image when T=0,(c)image when T=0.25,(d) image when T=0.5(e) image when T=0.75(f) image when T=1.(T is a scaling parameter)

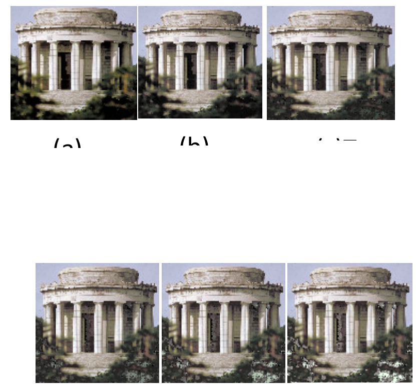


Fig .2. Output of Range preserving in optimal way enhancement using histogram equalization is a scaling parameter we already know by algorithm 3.(a)) input image,(b)image when T=0,(c)image when T=0.25,(d) image when T=0.5(e) image when T=0.75(f) image when T=1 (T is a scaling factor).

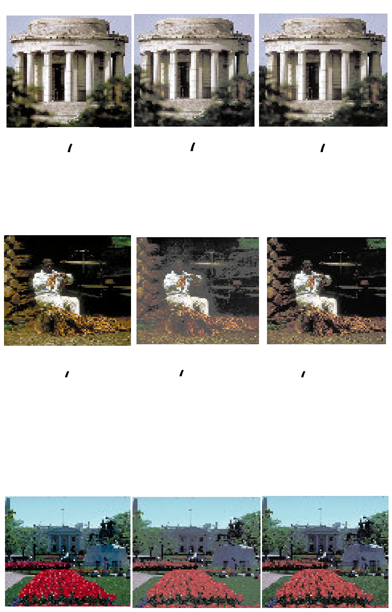


Fig.3. The output of Scaling colour enhancement using histogram specification (middle) and histogram equalization (right corner). If a dark pixel has wrong hue (e.g. due to compression or printing artifacts ,noise,colour cast,etc)the scaling algorithm can magnify the intensity of this wrong colour if the input image contains a lot such pixels, the shifting colour enhancement algorithm can be the better choice

(a,d,g,j,m)=original image.(b,e,h,k,n)=using exact HS (c,f,i,l,o)=using RMSHE (Recursive Mean Separate Histogram Equalization).

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

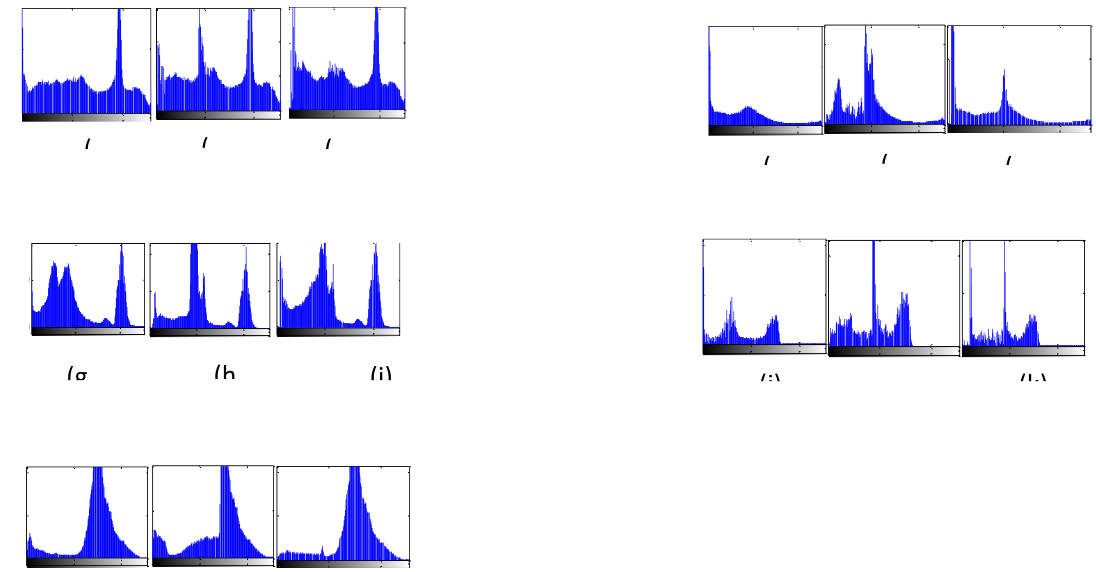
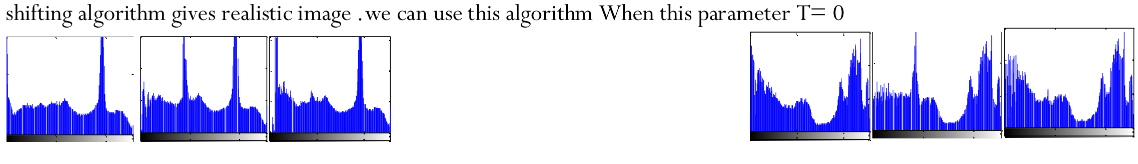


Fig .4. The histogram output of Scaling colour enhancement using histogram specification (middle) and histogram equalization (right corner). If a dark pixel has wrong hue (e.g. due to compression or printing artifacts, noise, colour cast,etc)the scaling algorithm can magnify the intensity of this wrong colour . if the input image contains a lot such pixels, the shifting colour enhancement algorithm can be the better choice.(a,d,g,j,m)=histogram of original image.(b,e,h,k,n)=histogram of exact HS (c,f,i,l,o)= histogram of RMSHE (Recursive Mean Separate Histogram Equalization).

Fig5. The output of Shifting colour enhancement. (a,d,g,j,m)=original image.(b,e,h,k,n)=using exact HS (c,f,i,l,o)=using RMSHE (Recursive Mean Separate Histogram Equalization).

The shifting algorithm gives realistic image .we can use this algorithm When this parameter T= 0



Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. “Image Enhancement Using Affine Histogram Equalization Model”. *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

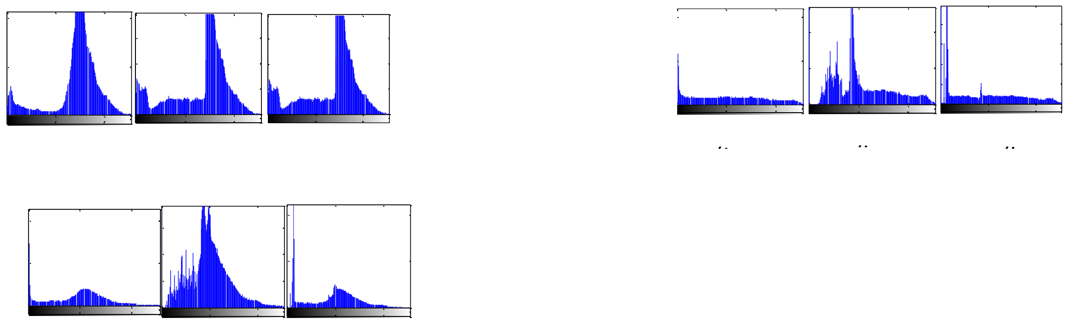


Fig6. The output of Shifting colour enhancement.(a,d,g,j,m)=histogram of original image.(b,e,h,k,n)=histogram of exact HS (c,f,i,l,o)= histogram of RMSHE (Recursive Mean Separate Histogram Equalization).

PERFOMANCE METRICS

The PSNR is commonly used as measure of quality reconstruction of image. High value of PSNR indicates the high quality of image. It is defined via the Mean Square Error (MSE) and corresponding distortion matric, the Peak Signal to Noise Ratio .

$$MSE=1/MN \sum_{m=1} \sum_{n=1} [f(m/n)-f'(m/n)] \quad (x)$$

$$PSNR= 10.\log10 [(255)2/MSE] \quad (y)$$

$$=20.\log10 (255)-10.\log10 (MSE)$$

Here Max is maximum pixel value of image when pixel is represented by using 8 bits per sample. This is 255 bar colour image with three RGB value per pixel.

The RMSE is a frequently used measure of the difference between values predicted by a model or an estimator and the values actually observed

$$RMSE=\sqrt{(1/n\sum_{i=1}} \; (y_i - y_i\,\hat{}\,)^2) \quad (z)$$

FOR SCALING ALGORITHM

Table 1 PSNR&RMSE comparison HS Vs HE

S.No	IMAGE	PSNR (HS)	PSNR (HE)	RMSE (HS)	RMSE (HE)
1.	Monument	66.9419	70.7593	0.1147	0.0739
2.	Roping	66.227	71.4759	0.1245	0.0680
3.	1600	65.9193	68.7029	0.129	0.0936
4.	Family	60.9302	69.9982	0.2291	0.0807
5.	Fisher	30.5147	67.2853	7.5999	0.1102

Table 1 shows PSNR comparison for Histogram Specification (HS) and Histogram Equalisation(HE) for images monument.jpg,roping.jpg,1600.jpg,family.jpg, fisher.jpg in which monument.jpg image has the highest PSNR value of 70.7593 for

Histogram equalization images compared to HS having 66.94 which is lower by 4dB. For all the images the PSNR value for HE is higher compared to HS applied images.

Table 2 MSE&SSIM comparison HS Vs HE

S.No	IMAGE	MSE (HS)	MSE (HE)	SSIM (HS)	SSIM (HE)
1.	Monument	0.0131	0.0055	0.9992	0.9997
2.	Roping	0.0155	0.0046	0.9789	0.9994
3.	1600	0.0166	0.0088	0.9932	0.9968
4.	Family	0.0525	0.0065	0 .9860	0.9971
5.	Fisher	57.7580	0.0121	0.9979	0.9992

Table 2 shows SSIM comparison for Histogram Specification (HS) and Histogram Equalisation(HE) for images monument.jpg,roping.jpg,1600.jpg,family.jpg, fisher.jpg in which monument.jpg image has the least RMSE value of 0.0680 for Histogram equalization images compared to HS having error of 0.1245 which is higher by 0.6. For all the images the RMSE value for HE is lower compared to HS applied images. Performance metrics table for scaling algorithm proves that Histogram equalization performs better that Histogram specification.

FOR SHIFTING ALGORITHM

Table 3 PSNR &RMSE comparison HS Vs HE

S.No	IMAGE	PSNR (HS)	PSNR (HE)	RMSE (HS)	RMSE (HE)
1.	Monument	65.5686	67.2689	0.1343	0.1104
2.	Bridge	64.844	72.4958	0.146	0.0605
3.	Fisher	29.9339	68.1058	8.1254	0.1003
4.	Snow_leaves	55.8659	69.6058	0.4104	0.0844
5.	Veggies	57.6427	57.8555	0.3345	0.3264

Similarly table 3 also shows the HE applied images performs better than HS applied images.

Table 4 MSE&SSIM comparison HS Vs HE

S.No	IMAGE	MSE (HS)	MSE (HE)	SSIM (HS)	SSIM (HE)
1.	Monument	0.018	0.0122	0.9992	0.9997
2.	Bridge	0.0213	0.0037	0.9989	1.0000
3.	Fisher	66.0228	0.0101	0.9958	0.9996
4.	Snow_leaves	0.1685	0.0071	0.9802	0.9994
5.	Veggies	0.1119	0.1065	0.9799	0.9993

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.

Table 4 shows SSIM performance shows the structural similarity of 0.9997 for HE applied monument image. Performance metrics table for shifting algorithm proves that Histogram equalization performs better that Histogram specification.

CONCLUSION AND FUTURE WORK

This paper gives best result for image enhancement. This work provides the first comprehensive and rigorous presentation of the vast family of histogram specification based affine colour assignment models. We have proposed a image enhancement using affine histogram specification model. We analysed the performances of this algorithm and two of its important cases as well as the gamut preserving method. As usual dealing with a topic creates many open questions we have to answer in our future research. Instead of the strength of the input image, we can consider other combinations between the RGB channels that are better adapted to human colour perception and to the image content. Moreover, it may be useful to take the saturation or chromaticity of the input image into account. Finally, a systematic approach to find the target histogram is clearly desirable and topic of future research. Since our algorithms are fast, extensions to video should be envisaged.

REFERENCES

[1] M. Nikolova and G. Steidl, "Fast sorting algorithm for exact histogram specification", Preprint hal-00870501, 2013.

[2] S. F. Naik and C. A. Murthy, "Hue-preserving colour image enhancement without gamut problem", *IEEE Trans. Image Process.*, vol. 12, no. 12, pp.1591–1598, Dec. 2003.

[3] M. Nikolova, Y.-W. Wen, and R. Chan, "Exact histogram specification for digital images using a variational approach", *J. Math. Imaging and Vision*,vol. 46, no. 3, pp. 309–325, Jul. 2013.

[4]S.-D. Chen and A. Ramli, "Contrast enhancement using recursive Mean-Separate histogram equalization for scalable brightness preservation,"*IEEE Trans. On Consumer Electronics*, vol. 49, no. 4, pp. 1301-1309, Nov. 2003.

[5] T. Arici, S. Dikbas, and Y. Altunbasak, "A histogram modification framework and its application for image contrast enhancement", *IEEE Trans. Image Process.*, vol. 18, no. 9, pp. 1921–1935, Sep. 2009.

[6] V. Caselles, J. L. Lisani, J. M. Morel, and G. Sapiro, "Shape preserving local histogram modification", *IEEE Trans. Image Process.*, vol. 8, no. 2, pp.220–229, Feb. 1999.

[7] N. Papadakis, E. Provenzi, and V. Caselles, "A variational model for histogram transfer of colour images," *IEEE Trans. Image Process.*,vol. 20, no. 6, pp. 1682–1695, Jun. 2011.

Cite this article as: J Kanimozhi, P Vasuki, K G Sowmiyadevi, S Padma, G L Vijayalakshmi. "Image Enhancement Using Affine Histogram Equalization Model". *International Conference on Innovative Trends in Electronics Communication and Applications (2015)*: 104-114. Print.