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RESEARCH ARTICLE

IMPROVEMENT USING WEIGHTED METHOD FOR HISTOGRAM EQUALIZATION IN PRESERVING THE COLOR QUALITIES OF RGB IMAGE

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Abstract: Image enhancement fields continuously attracting researches to research on to gets more and more clarity or enhancement in contrast using several methods in image histogram. We are going to propose an algorithm to enhance image histogram using intensity weighing criteria for preserving color qualities for Gray Scale Images and RGB images. We are going to optimize our color space by introducing weighting method for predicting new color space for gray scale images and RGB images.

Keyword: Contrast; Digital Image Processing; Histogram; Histogram Equalization; Image Enhancement; MSE; PSNR; Tenengrad

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I. INTRODUCTION

Image enhancement is to improve the interpretability or perception of information in the images to provide better input for other automated image processing steps. The image acquired from natural environment with high dynamic range includes both dark and bright regions. Due to exceed in dynamic range of human eyes sensing, those images are difficult to perceive by human eyes. Image enhancement is a common approach to improve the quality of those images in terms of human visual perception. Enhancement techniques can be divided into two categories namely:

- Spatial domain methods
- Transform domain methods.

Spatial domain technique enhances an image by directly dealing with the intensity value in an image. Transform domain enhancement techniques involve transforming the image intensity data into a specific domain by using methods such as DFT, DCT, etc. and the image is enhanced by altering the frequency content of the image.
Image enhancement is applied in every field where images are ought to be understood and analyzed. For example, medical image analysis, analysis of images from satellites etc. Image enhancement simply means, transforming an image *f* into image *g* using *T*. (Where T is the transformation. The values of pixels in images f and g are denoted by r and s, respectively. As said, the pixel values r and s are related by the expression,

$$s = T(r)$$

Where T is a transformation that maps a pixel value r into a pixel value s. The results of this transformation are mapped into the grey scale range as we are dealing here only with grey scale digital images. So, the results are mapped back into the range [0, L-1], where $L=2^k$, k being the number of bits in the image being considered. So, for instance, for an 8-bit image the range of pixel values will be [0, 255].

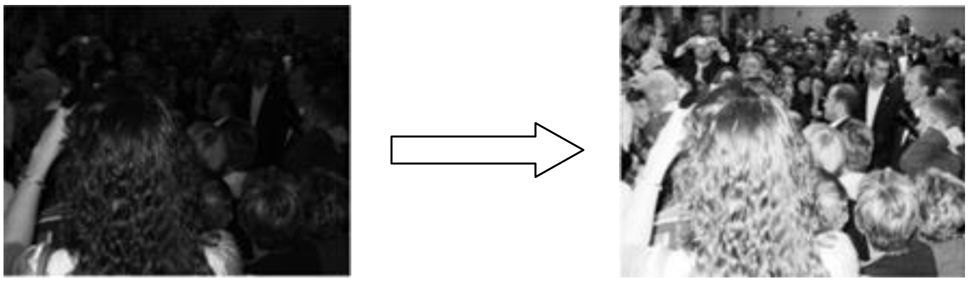


Fig 1: Showing the effect of Image Enhancement

II. HISTOGRAM EQUALIZATION

Histogram Equalization is a technique that is used to enhance the image contrast by basically stretching the dynamic range of the image. Histogram Equalization is a technique that generates a gray map which changes the histogram of an image and redistributing all pixels values to be as close as possible to a user - specified desired histogram. HE allows for areas of lower local contrast to gain a higher contrast. Histogram equalization automatically determines a transformation function seeking to produce an output image with a uniform Histogram

The input Probability density function of each gray level in the image is

$$P_k = n_k / N \quad \text{where } k = 0, 1, 2, \ldots\ldots m-1 \qquad (1)$$

Where 'm' is the maximum gray level used in histogram equalization. The cumulative density function of each image is

$$C(x) = \sum_{j=0}^{m-1} Pj \qquad (2)$$

Using these cumulative density function the transform function for each image is defined as

$$F(x) = X_0 + (x_t - X_0) C(x) \qquad (3)$$

Histogram equalization is one of the most commonly used contrast enhancement methods on almost all types of images. This popular method only requires the low computational complexity to facilitate the subsequent high-level operations such as detection and recognition.

INTENSITY WEIGHTED CRITERIA:

Intensity weighted criteria or weighted sum method is a method or algorithm used for image enhancement. The weighted sum method is implemented on the images which are having low contrast and poor quality to improve the quality of the image using the image enhancement technique that is, Histogram Equalization. The weighted sum model (WSM) is the best known and simplest multi-criteria decision analysis (MCDA) / multi-criteria decision making method for evaluating a number of alternatives in terms of a number of decision criteria. The weighted sum criteria basically work on the principle of the multiple decision criteria.

In general, suppose that a given MCDA problem is defined on *m* alternatives and *n* decision criteria. Furthermore, let us assume that all the criteria are benefit criteria, that is, the higher the values are, the better it is. Next suppose that w_j denotes the relative weight of importance of the criterion C_j and a_{ij} is the performance value of alternative A_i when it is evaluated in terms of criterion C_j. Then, the total (i.e., when all the criteria are considered simultaneously) importance of alternative A_i, denoted as $A_i^{\text{WSM-score}}$, is defined as follows:

$$A_i^{\text{WSM-score}} = \sum_{j=1}^{n} wj \;\; a_{ij}, \;\; \text{for } i = 1, 2, 3, \ldots\ldots, m.$$

Where A^{WSM} is the WSM score of the best alternative, *N* is the number of decision criteria, *aij* is the actual value of the *i-th* alternative in terms of the *j-th* criterion, and *Wj* is the weight of importance of the *j*-th criterion.

III. PROPOSED METHOD

In the proposed method the image is being enhanced using the weighted method using Histogram Equalization. In this the image contrast is being enhanced to a specific range that the image color quality does not change. The objects in an image require the contrast enhancement rather than the background. The Global Histogram Equalization involves each and every pixel for equalization. The algorithmic flow of the proposed method is explained in Fig 2

1. Extracting R, G, B colors: color separation technique is used to extract Red, Green and Blue colors and histogram entities are shown. With the help of these histograms we can easily describe the three different colors of the image. Histogram drawn is a plot of intensity values (x-axis) and density values (y-axis)

2. Predicting the no. of colors present: Image is sized into matrix form having separate variables r (rows) and c (columns). Matrix is taken column-wise and unique colors are calculated. Then number of particular colors present are calculated, Then RGB combine histogram is calculated and also the length of individual object.

3. Implementing New Color space to Original Image using weighted sum criteria: After calculating the unique colors present in the image we are finding the length of the object after finding the length of the object we are calculating the mean value of the objects length

- Predicting weights for individual: Weight of the individual object is calculated and the percent wise area is also calculated.
- Allocating new color space with weighted sum: Using this area and the weight we predict those pixels which are having low contrast and after finding those pixels we allocate new color space to those pixels with the help of weighted sum method.

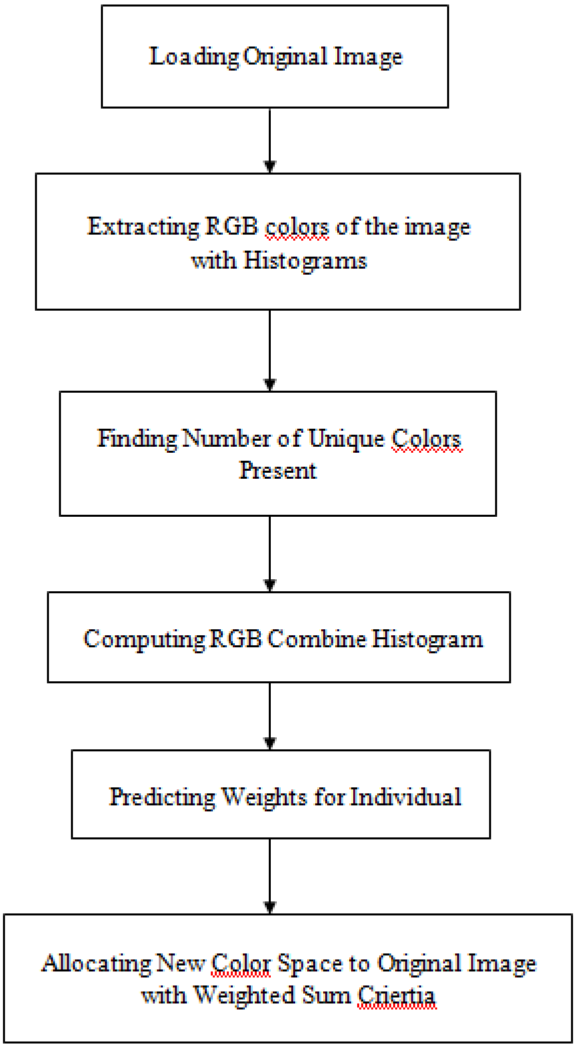


Fig 2: Block Diagram of the Proposed Algorithm

IV. RESULTS AND DISCUSSION

The proposed algorithm is tested for various images. Gray scale images and colored images are used for experimentation. The proposed method is compared with the object based histogram equalization methods. The following images “hands.jpg”, “couple.jpg”, “boy” images are used to verify the performance of the proposed algorithm. Two another coloured images are also used to verify the performance of proposed algorithm.
To confirm the improvement in contrast, hence, the visual quality of image, well-known criteria like brightness of the image, PSNR, Tenengrad and contrast are used to compare the results of the proposed method and the conventional methods.

MSE: MSE means Mean Square Error, The MSE represents the cumulative squared error between the compressed and the original image. The lower the value of MSE, the lower the error.

$$\text{MSE} = \frac{\sum_{M,N}[I1\ (m,n) - I2\ (m,n)]^2}{M * N}$$

M and *N* are the number of rows and columns in the input images

PSNR: PSNR means the Peak Signal to Noise Ratio, The PSNR block computes the peak signal-to-noise ratio, in decibels, between two images. This ratio is often used as a quality measurement between the original and a compressed image. The higher the PSNR, the better the quality of the compressed or reconstructed image. PSNR represents a measure of the peak error. To compute the PSNR, the block first calculates the mean-squared error using the following equation:

$$\text{PSNR} = 10 \log_{10} \left[\frac{R^2}{MSE} \right]$$

Tenengrad: It is used for Measurement of image sharpness. The tenengrad parameter is calculated using

$$\text{Gh} = \sum_{i=1}^{M} \sum_{j=1}^{N} G_{i,j}$$

Where

$$G_{i,j} = \sqrt{(G_x^2 + G_y^2)}$$

Where 'G_x' is the horizontal gradient of the image and 'G_y' is the vertical gradient of the image.

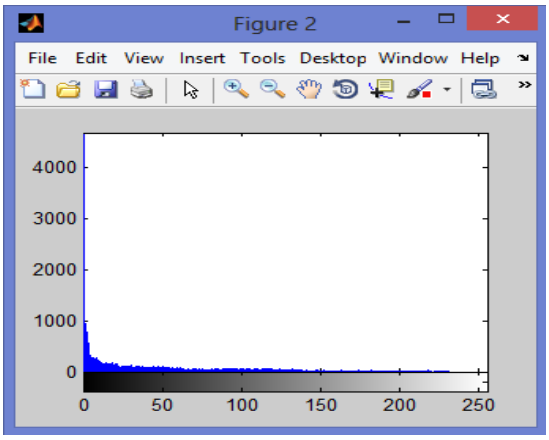
Contrast: It measures the average distance between pixels of image. The Contrast in a particular 3X3 window of pixels x1, x2, x3, x4, x5, x6, x7, x8, x9 where x5 is the pixel to be replaced, is calculated based on the joint occurrence of local binary pattern and contrast as follows:

$$C(x_5) = (1/n) \sum_{m=1}^{n} X_m + (1/\,9\text{-}n) \sum_{k=1}^{9-n} X_k$$

Where $X_m > X_5$ for m=1 to n and $X_k < X_5$ for k=1 to 9-n.

The quality measures of the enhanced images using proposed algorithms shows that the performance of the proposed algorithm gives better results compared to conventional HE methods. The experiments are performed on 5 test images and simulation results on a few natural images are shown in figure 3 to 7 (i.e. Image 1, Image 2, Image 3, Image 4, and Image 5). This is shown in Table 1 and Table 2.

(a)



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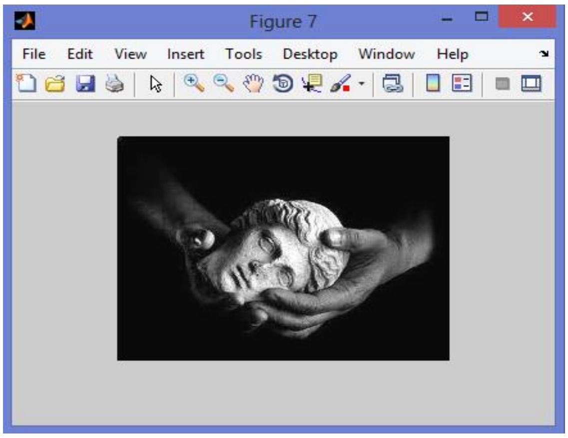
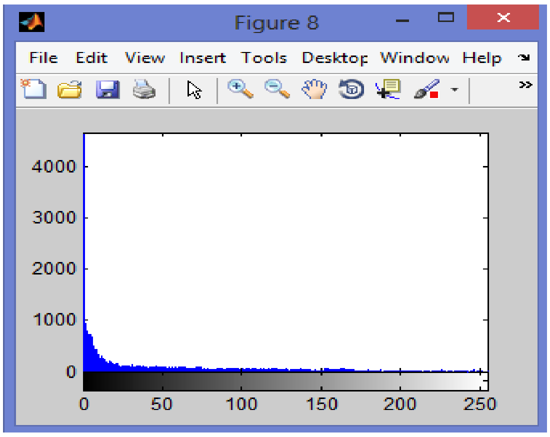
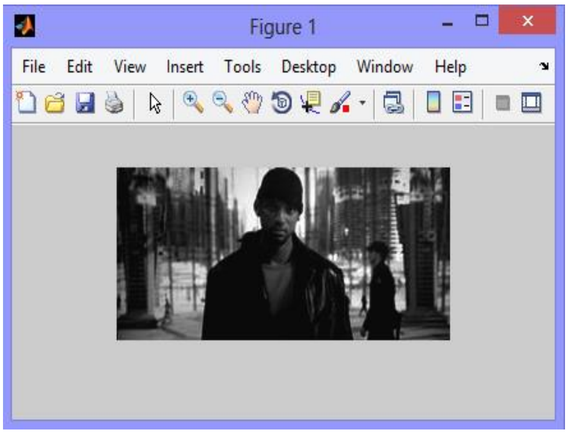
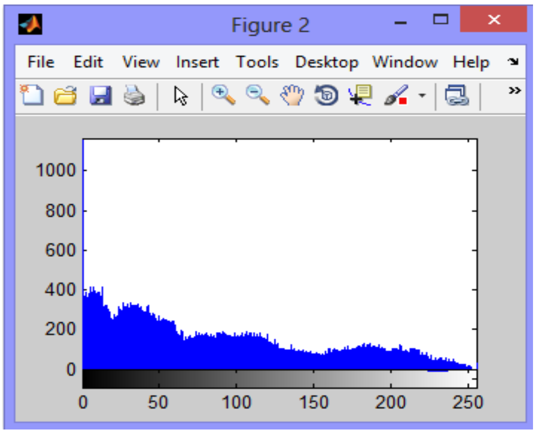




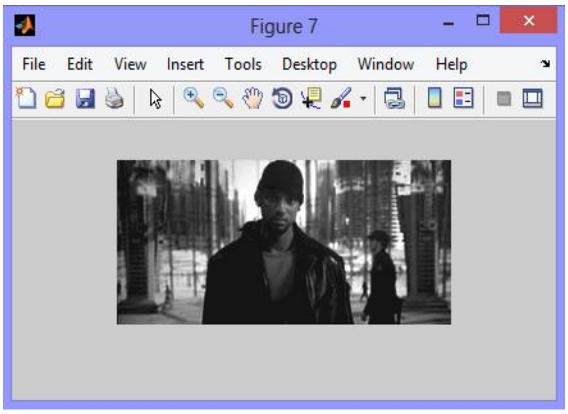
(c) (d)

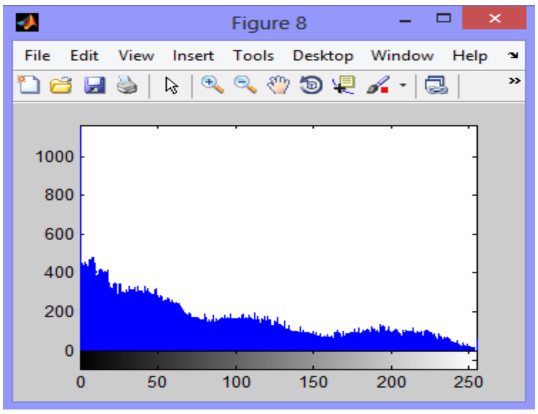
Fig 3: (a) Original image (b) Histogram of original Image (c) Enhanced Image (h) Histogram of Enhanced Image





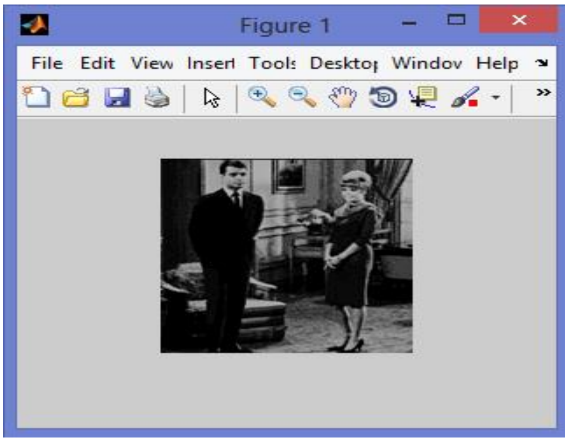
(a) (b)



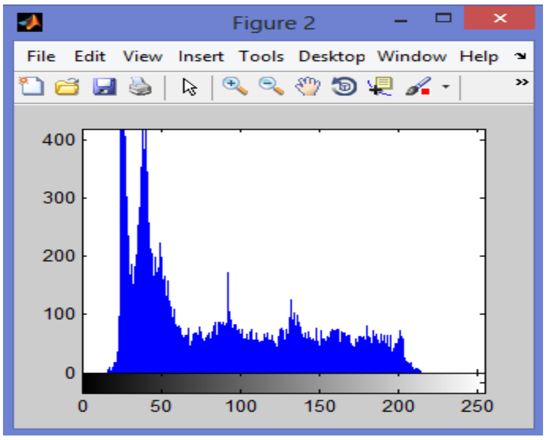


(c) (d)

Fig 4: (a) Original image (b) Histogram of original Image (c) Enhanced Image (d) Histogram of Enhanced Image

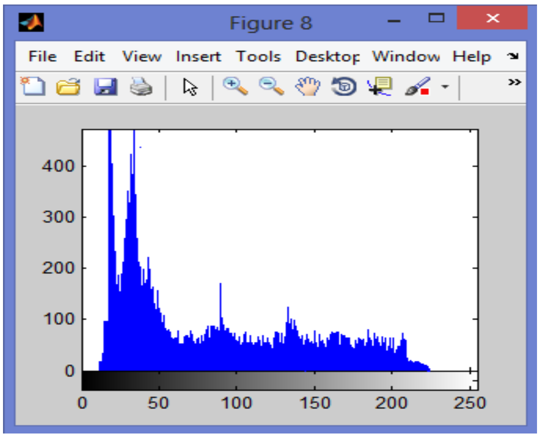


(a)



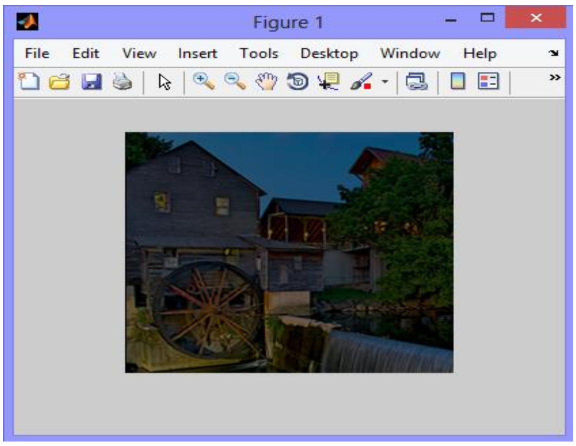
(b)

(c)



(d)

Fig 5: (a) Original image (b) Histogram of original Image (c) Enhanced Image (d) Histogram of Enhanced Image



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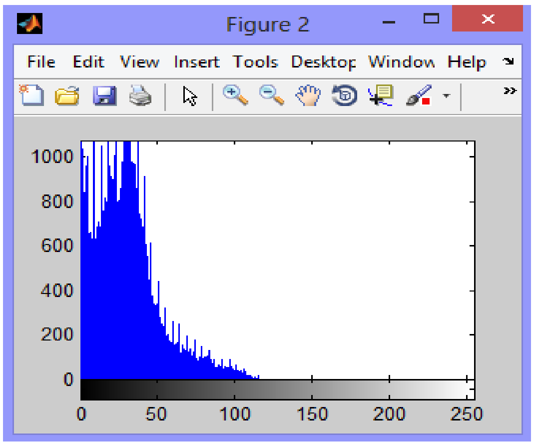

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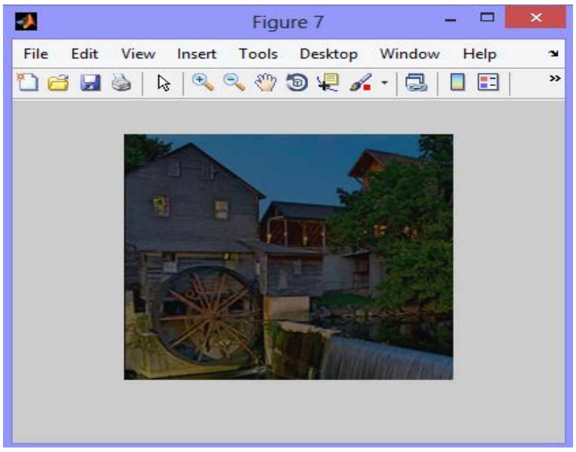
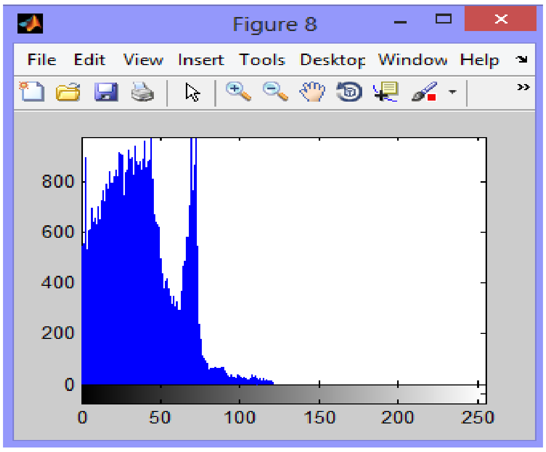
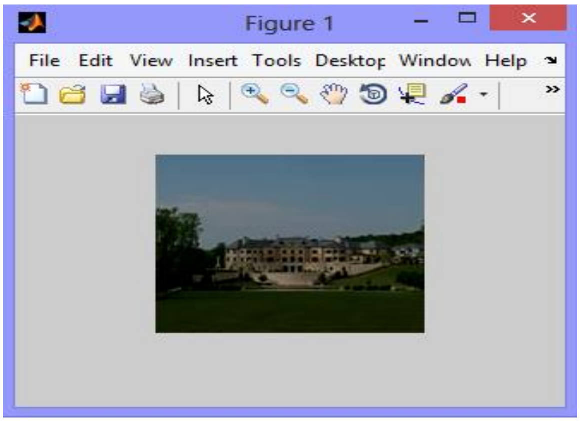


(c)



(d)

Fig 6: (a) Original image (b) Histogram of original Image (c) Enhanced Image (d) Histogram of Enhanced Image



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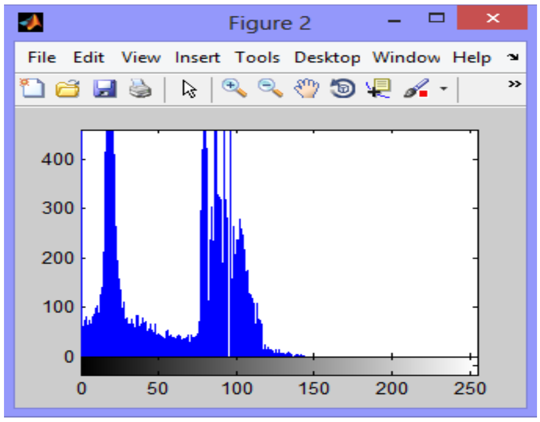

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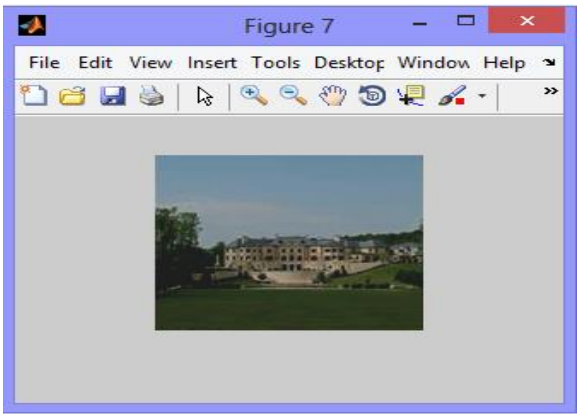
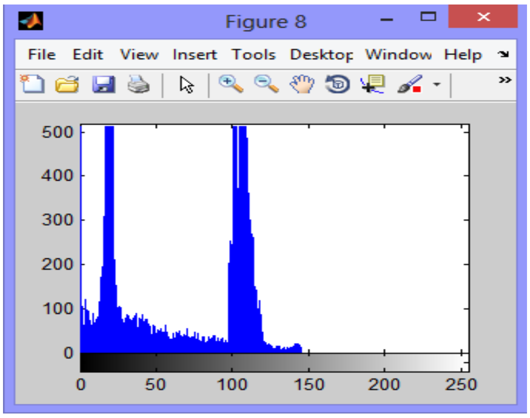


(c)



(d)

Fig 7: (a) Original image (b) Histogram of original Image (c) Enhanced Image (d) Histogram of Enhanced Image

Table 1: The PSNR, Tenengrad and Contrast Values of Fig 3, Fig 4 and Fig 5

	Enhancement Method	PSNR	Tenengrad	Contrast
Image 1	ORIGINAL IMAGE		181533	8.7383
	OBHE	32.4353	342229	13.44
	Prop	40.9852	352114	24.7012
Image 2	ORIGINAL IMAGE		177388	12.9260
	OBHE	28.3523	338859	17.6545
	Prop	33.6223	434819	46.1402
Image 3	ORIGINAL IMAGE		215723	11.0209
	OBHE	28.9848	307862	19.77
	Prop	33.8484	354297	57.3029

Table 2: The MSE, PSNR, Tenengrad and Contrast Values of Fig 6 and Fig 7

	MSE	PSNR	Tenengrad	Contrast
Image 4	3.4179	42.7933	384907	27.6683
Image 5	8.4177	38.8789	128007	23.1315

V. CONCLUSION

In this paper, an efficient algorithm is implemented. The colors of the image are preserved by using weighted method sum based histogram equalization. Since the artifacts in the image are removed by implementing the new color space. Contrast enhancement techniques are widely used for improving visual quality of low contrast images. The experimental results show that proposed method preserves naturalness of the original image compared with conventional methods. The objects hidden due to contrast are more clearly visible with our proposed method. Also the proposed method provides better performance in terms of all metrics such as higher PSNR value, the best Tenengrad Value and Contrast value.

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