EVALUATING THE PERFORMANCE OF DOMINANT BRIGHTNESS LEVEL BASED COLOR IMAGE ENHANCEMENT

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Abstract: This paper has been defined the different techniques of image enhancement. Image enhancement has originated to be one of the most significant visualization applications for the reason that it has capability to improve the visibility of images. It improves the quality of poor images. Distinctive procedures have been projected so far for getting better the feature of the digital images. To improve picture superiority image enhancement can explicitly recover and bound some data accessible in the input image. This paper has evaluated the performance of dominant brightness level based image enhancement technique. By using image processing toolbox, the design and implementation has been done in MATLAB. The comparison among the dominant brightness level, histogram equalization and the adaptive histogram equalization has shown that the dominant brightness level outperforms over the histogram based image enhancement.

Keywords: Enhancement, Histogram Equalization, Adaptive Histogram Equalization, Dominant Brightness Level, Human Visual Perception.

1. INTRODUCTION
Image enhancement is generally simplest and interesting areas of digital image processing. Image enhancement is method used to improve the overall quality of the degraded images can be achieved by using enhancement methods. So that the human eye can easily observe the main features of the image. It is used to remove the irrelevant artefacts from the images like noise or brighten an image and it easier to recognize key features and then it looks better. It is a very subjective area of digital image processing. To make a graphic display more helpful to visualize and analysis, it improve the image features such as edges or boundaries. It increases the dynamic range of selected features. It does not raise the inherent content of data. It can be broadly divided into two categories:

a. Spatial Domain Method: which directly operate on pixel. The operation can be formulated as
\[ g(x, y) = T(f(x, y)) \]
Where g is the output, f is the input image and T is an operation on f defined over some neighborhood of (x, y).

b. Frequency Domain Method: which operate on the Fourier Transform? Frequency domain image enhancement is straightforward. The frequency filters developed an image in the frequency domain. This type filtering technique is very simple:
1. Transform the image into the Fourier domain
2. Multiply the image by the filter
3. Take the inverse transform of the image

Figure 1. Results of enhancement (a) before enhancement (b) after enhancement

2. HISTOGRAM EQUALIZATION [HE]
Histogram equalization is the method of image enhancement that is used to enhance the contrast of images. In HE it is not compulsory that the contrast of an image will always be raised. Sometimes it shows that it can be not as good as than the contrast of an image reduced. Before working with HE it’s necessary to recognize the two main concepts of histogram equalization that are known as PMF (probability mass function) and CDF (cumulative distributive function). First of all estimate the PMF and CDF for all pixels in an image then work further. The transformation T(r) needed to be obtain by using this formula as
\[ s = T(r) = p_s(r) dr = cdf \]  
HE is further divided into two broad categories:

a. Local Histogram Equalization: The overall contrast of an image can be improved efficiently.

b. Global Histogram Equalization: Based on grey level content of an image, the pixels are modified by transformation function. Histogram equalization is a point process. In order to obtain a uniform histogram for an image the point process redistributes the image’s intensity distribution. HE can be done in three main steps:
1. Compute the histogram of an image.
2. Calculate the normalized sum of histogram.
3. Transform the input image to an output image.
Adaptive histogram equalization [AHE] is a computer image processing technique used to improve contrast of the images. Adaptive histogram equalization [AHE] is a brilliant contrast enhancement for both natural images and medical images and other initially non visual images. It differs from ordinary histogram equalization [HE] in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute lightness value of the image. In image fusion process, fusion process may degrade the sharpness of the fused image so to overcome this problem of poor brightness adaptive histogram equalization will be used to enhance the results further. We can say that adaptive histogram equalization will come in action to preserve the brightness of the fused image. The main point of AHE [2 my ppr] is that in which at smaller scales contrast of an image is enhanced, while at larger scales contrast of an image is reduced or decreased. The advantage of adaptive histogram equalization [AHE] is that it is automatic, reducible, and locally adaptive and usually produces superior images.

**3. ADAPTIVE HISTOGRAM EQUALIZATION [AHE]**

Adaptive histogram equalization (aHE) is a computer image processing technique used to improve contrast of the images. Adaptive histogram equalization [AHE] is a brilliant contrast enhancement for both natural images and medical images and other initially non visual images. It differs from ordinary histogram equalization [HE] in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute lightness value of the image. In image fusion process, fusion process may degrade the sharpness of the fused image so to overcome this problem of poor brightness adaptive histogram equalization will be used to enhance the results further. We can say that adaptive histogram equalization will come in action to preserve the brightness of the fused image. The main point of AHE [2 my ppr] is that in which at smaller scales contrast of an image is enhanced, while at larger scales contrast of an image is reduced or decreased. The advantage of adaptive histogram equalization [AHE] is that it is automatic, reducible, and locally adaptive and usually produces superior images.

**4. DOMINANT BRIGHTNESS LEVEL ANALYSIS**

Dominant Brightness means that is effective or impressible technique for the images. Contrast enhanced images may contain intensity distortion and lose image information in various regions. To overcoming the problems of contrast enhanced images, to decompose the input image into several layers of single dominant brightness levels. The image can be equally decomposed into different levels so that it can be easily handled.

**Figure 2.** Results of histogram equalization (a) original image (b) output result of histogram equalization

**Figure 3.** The results of adaptive histogram equalization (a) original image (b) output results of adaptive histogram equalization

**Figure 4.** The results of dominant brightness level (a) original image (b) output results of DBL

After that to execute the discrete wavelet transform on remote sensing images and then calculate the dominant brightness level by using the log-average luminance in the low-low sub band, to use the low frequency luminance components. In view of the fact that high-intensity values are dominant in the bright region, and vice versa, the dominant brightness at the position \((x, y)\) is computed.

\[
D(x,y) = \exp \left( \frac{1}{\epsilon} \sum_{i=0}^{NL} \log(\epsilon \cdot I(x,y) + 1) \right)
\]

Where \(S\) represents a rectangular region encompassing \((x, y)\), \(L(x, y)\) represents the pixel intensity at \((x, y)\), \(NL\) represents the total number of pixels in \(S\), and \(\epsilon\) represents a sufficiently small constant that prevents the log function from diverging to negative infinity. The low-intensity layer has the dominant brightness lower than the pre specified low bound. The high intensity layer is determined in the similar manner with the pre specified high bound, and the middle-intensity layer has the dominant brightness in between low and high bounds. The normalized dominant brightness varies from zero to one, and it is practically in the range between 0.5 and 0.6 in most images. For safely including the practical range of dominant brightness, we used 0.4 and 0.7 for the low and high bounds, respectively.

**5. RELATED WORK**

Veena et al. (2013) [1] for the improved visual observation and color imitation. By using Discrete Wavelet transform and singular value Decomposition, Discrete Cosine Transform the Histogram equalization, Contrast Enhancement, Bi-histogram equalization discussed the basic enhancement methods and projected method contrast enhancement based on dominant Brightness and Adaptive transformation. The concert of each technique has evaluated with parameters like Mean Square Error, Measure of Enhancement Peak Signal to Noise ratio and Mean absolute error. Without changing original image quality it has an appropriate for enhancement of low contrast satellite image. Srivastava et al. (2013) [2] Histogram equalization has one of the best method that is very effective method to process the digital contrast enhancement but has not been suitable for every image. Sometimes it shows not good outcomes. To overcome this problem it provides a new method to improve the image result. In this interact with histogram that reflects improved outcomes as compare to conservative one. On the basis of Absolute mean brightness error and peak Signal to Noise Ratio values. It has an appropriate for real time applications. Lee et al. (2013) [3] The work has based on the satellite images the low contrast images used as an input after applying all the methods the result has the better quality image. For remote sensing images on the basis of adaptive intensity transfer function and dominant brightness level analysis proved a new contrast enhancement technique. It divide the input image into four wavelet subbands and split the LL subband into low-, middle-, and high-intensity layers by analyzing the log-
average luminance of the resultant layer. After that apply adaptive intensity transfer function and then implement contrast enhancement technique then combine the decomposed image by using image fusion method after that at last use inverse discrete wavelet transform method. Then the contrast enhanced image has ready as a result. Thien Huynh and Thuong Le-Tien (2013) [4] provide a method for preserving the intensity and visual artifacts. For sorting out the original histogram, intensity preserving weighted dynamic range HE used in class variance. The way focus on separating point based on variance to reduce the squared error of sub-histogram related to brightness shift with HE. The outcome has exposed enhanced the contrast and also preserves the brightness. The outcomes proved the technique superior than others methods in overall brightness, the discrete entropy, the local contrast. Cheng and Zhang (2012) [5] the major limitation of contrast enhancement algorithm has Over-Enhancement which could stimulate the loss of edges, alter the main texture, damage the fine details, and create the image appearance unnatural. It has no efficient reason for Over-enhancement until now. It provides a new technique for the recognition of Over-enhancement.

1. To investigated and analyzed profoundly
2. The purpose for detecting over-enhancement has projected.

The outcomes show that the projected technique can establish the Over-enhancement areas perfectly and efficiently and give a quantitative method to assess the Over-enhancement levels fine. Ahmed etal. (2012) [6] our learning uncovers that HE - in a remarkable contrast to its claim, is not associated to enhancement of contrast. To recognize this observation, we begin through real world images which have variable amount of image quality that almost consistently want processing to get better image contrast. For this reason, HE is used upon technique. HE is working with grey level of images. As a result, the learning aims to get out the realistic nature of alteration functions used by HE. To recognize these calculations, this paper dismantles histogram equalization into its building blocks. These blocks show the relationship between fundamentals and contrast of HE. In this different keywords are used like Histogram equalization, Cumulative density function, probability density, contrast. Khan etal.(2012) [7] for contrast enhancement HE is one of the most efficient method, but it does not protect the mean brightness of images. To overcome these problem different methods has been proposed like bi-HE and multi-HE techniques. Bi-HE is the technique that prevents the brightness, but it will begin various unwanted artifacts in the processed image. On the other side, multi-HE technique may not begin these type of artifacts. In this paper by using Gaussian filter for contrast enhancement of natural images propose a weighted average multi segment histogram equalization technique. Use the method of global HE and divide it into several parts via optimal thresholds, then independently applied HE to each part. Different methods are used in this paper like Gaussian filter, histogram segmentation, HE, contrast enhancement, brightness preservation. Amina saleem et.al (2012) [8] planned a scheme that balances the situation of local and global contrast enhancements and a reasonable illustration of the original image and defeat the limitations of altered contrast enhancement that is fusion-based contrast enhancement algorithms. By using laplacian pyramid decomposition techniques has used for fusion. The results show that enhancing the local and global contrasts. Ghimire and Lee (2011) [9] work has been focused on nonlinear color image enhancement techniques. The purpose of image enhancement has to get better some features of an image to construct it visually good one. It shows the image enhancement has applied only on the V(luminance value) component of the HSV color image and H & S component need no modification for enhancement because these components has not been changed. The V element enhanced in two steps. In first step the V element by using non linear transfer function has divided into smaller overlapped blocks and for every pixel within the block the luminance enhancement has accepted out. In the next step the contrast enhancement method has applies on it. At last the H and S element image and V element has converted back to RGB Image. The result shows that enhancement has one of the best methods for the image enhancement. Roomi and Prabhu et al. (2011) [10] provided that for better visualization of low contrast images contrast enhancement method has been used. Histogram equalization used for Contrast enhancement. Histogram equalization has not suitable for consumer electronics product straightforwardly. It provides a new method of histogram equalization that tries to found foreground and background pixels of an image and apply bi-histogram equalization on them. Its outcomes shows that this algorithm preserves the original image as compare to other techniques. Chauhan and Bhadoria (2011) [11] Histogram equalization has predictable technique for contrast enhancement. Histogram equalization has some limitations. Histogram equalization recovers the disparity of an image by altering the intensity level of the pixel based on the intensity of the original image. To overcome these problems apply brightness preserving weight clustering histogram equalization that protect image brightness and enhance visual effects of an image efficiently as compare to histogram equalization technique. Josephus and Remya S (2011) [12] proved that for local content emphasis that the adaptive histogram equalization has the best and efficient algorithm. But sometimes has a problem of amplification and introduction of the speckle noise due to it information lost. To overcome this problem the multilayered contrast limited adaptive histogram equalization with frost filter that focused on application to medical images. In this on contrast limited adaptive histogram equalization the combination of frost and median filter both has been used. For the removal of speckle noise in images the technique of frost filter has been done. The work has been done on medical images such as mammogram, knee, and brain images. Demirel et al. (2010) [13] provided a novel satellite image contrast enhancement method based on the discrete wavelet
transform and singular value decomposition has been projected. In this method by using discrete wavelet transform divide the input image into the four frequencies subbands and estimates the singular value matrix of low-low subband image and then restructure improved by applying inverse discrete wavelet transform. The illustration results on the finishing image quality show the advantage of the projected technique over the predictable and the state-of-the-art method. The different techniques used for example discrete wavelet transform, Image equalization and satellite image contrast enhancement. Compare the techniques with general histogram equalization and local histogram equalization. Ke et al. (2010) [14] This provide there are so many types of image enhancement techniques that makes the image results better that associate to the person visual system. It includes the two techniques bilateral tone Adjustment and Saliency Weighted Contrast Enhancement both combined in image enhancement framework. The main scenes that are contained in mid-tone regions enhanced by bilateral tone adjustment in most of the curve-based global contrast enhancement techniques. The saliency-weighted Contrast enhancement integrates the notion of image saliency into an easy filter-based contrast enhancement technique. It performs extra enhancement in regions that persons give larger concentration to. By using the luminance component in this saliency weighted contrast enhancement achieves extra performance. It proved that to achieve higher contrast enhancement with slight sound and huge image quality. Murahira et al. (2010) [15] proved for improving images histogram equalization is one of the general technique. On the other hand, it will cause a consequence on the brightness saturation or shadow in several identical areas. To overcome these things mean preserving bi-histogram equalization technique has been developed. New histogram equalization with variable enhancement degree and bi-histogram equalization with variable degree has developed. By only one parameter the degree of every of these techniques has controlled. Every type of images is enhanced effectively. The outcomes show that especially, bi-histogram equalization with variable degree can recognize the normal enhancement. P. jaatheeswari et al. (2009) [16] by HE, contrast enhancement of an image can be effectively worked. On the other hand, this technique to produce irrelevant visual deterioration likes saturation effect. To overcome this drawback is by preserving the mean brightness of input image inside the output image. In this paper for image contrast enhancement and brightness preservation, introduce a new technique contrast stretching recursively separated histogram equalization. Two stages of algorithm are to be applied. Different keywords that were used in this paper like image contrast enhancement, contrast stretching, image contrast enhancement and histogram equalization. Garg et al. (2011) [17] different enhancement methods like gray scale manipulation, filtering and HE are used to enhancing an image. HE is very important and known image enhancement method. It is a famous method for contrast enhancement just because it is easier and efficient. In HE it is not compulsory that the contrast of an image will always be raised. Sometimes it shows that it can be not as good as than the contrast of an image reduced. In this paper compare different enhancement methods on the basis of the performance analysis methods like PSNR, MSE, NAE, CPSNR and normalized correlation.

7. EXPERIMENTAL RESULTS

This section contains the experimental results. The overall section contains the original image, Histogram Equalization, AHE, Dominant brightness analysis level results.

Figure5. Input image
Figure5 has shown the input image without any degradation.

Figure6. HE image
Figure6 has shown the effect of HE on input image. It shows the clear difference between input image and the effect of HE image.

Figure7. AHE image
Figure7 has shown the effect of AHE on input image. There is clear difference between input image and the effect of AHE image.

Figure8. Dominant brightness levels analysis image
Figure8 has shown the effect of dominant brightness levels analysis of image. The brightness level of image is increases.

8. PERFORMANCE ANALYSIS

This section is used to show the performance analysis between existing and proposed techniques. These parameters are very important part of the digital image processing. In this different parameters are used to show
the performance of proposed method is better than the existing algorithm.

### 8.1 Mean Square Error Evaluation

In image processing mean square error is the most general measure for performance measurement of the existing method and the coded images. It is straightforward method to design system that decrease the MSE but cannot capture the impurities like blur artifacts. It is computed by using equation

\[
MSE = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} (f(i,j) - \hat{f}(i,j))^2
\]

#### Table 8.1 Mean Square Error Evaluation

<table>
<thead>
<tr>
<th>Image</th>
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<th>HE</th>
<th>DBL</th>
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<td>264</td>
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<td>Image2</td>
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<td>6749</td>
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<td>Image3</td>
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<tr>
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</table>

![Graph 1] MSE of AHE, HE and DBL

Graph 1 has shown the quantized analysis of the mean square error of different images by using AHE (Black Color), HE (Orange Color) and DBL (White Color). It is especially clear from the plot that there is decrease in MSE value of images. This decrease shows enhancement in the objective quality of the image.

#### 8.2 Peak signal to noise ratio

Peak signal to noise ratio measure the degree of image distortion. PSNR is used to measure the quality between the original image and compressed image. If the value of PSNR is higher, then the quality of reconstructed image is better PSNR represent the peak error. To measure the PSNR first complete the MSE. Signal in the case of image is the original data and when noise is introduced in the image it becomes error.

PSNR is defined as:

\[
PSNR = 10 \cdot \log_{10} \left( \frac{MAX^2}{MSE} \right)
\]

\[
= 20 \cdot \log_{10} \left( \frac{MAX}{\sqrt{MSE}} \right)
\]

\[
= 20 \cdot \log_{10}(MAX) - 10 \cdot \log_{10}(MSE).
\]

#### Table 8.2 Peak Signal to Noise Ratio Evaluation

<table>
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<th>Images</th>
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<td>22.6030</td>
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</table>

![Graph 2] PSNR of AHE, HE and DBL

Graph 2 has shown the quantized analysis of the peak signal to noise ratio of different images by using AHE (Black Color), HE (Orange Color) and DBL (White Color). It is especially clear from the plot that there is increase in PSNR value of images. This maximization shows enhancement in the objective quality of the image.

#### 8.3 Root Mean Square Error

The root mean square error is a generally used to compute of the difference among values predicted by a model and values actually observed from the surroundings that is being modelled. The RMSE of a model total with respect to the estimated variable \( \hat{y} \) is defined as the square root of the mean squared error:

\[
RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (y(i) - \hat{y}(i))^2}
\]

#### Table 8.3 Root Mean Square Error

<table>
<thead>
<tr>
<th>Images</th>
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![Graph 3] RMSE of AHE, HE and DBL

Figure 7.3 is showing the relative analysis of the Root Mean Square Error (RMSE). As RMSE need to be minimized; therefore the key goal is to reduce the RMSE as much as possible. It is providing better results than the available methods.
8.4 Average Difference
Less the value of Average difference [AD] that gives the result more clear and appropriate and reduce the noise from image by using equation of AD

\[ \text{AD} = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} |u(x, y) - v(x, y)| \]

<table>
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<th>Image</th>
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Graph4. Average Error of AHE, HE and DBL

Graph4 is showing the comparative analysis of the Average Difference. As Average Difference needs to be minimized; so the main objective is to reduce the Average Difference as much as possible. It shows better results as compare to existing methods.

9. CONCLUSION AND FUTURE SCOPE
The image enhancements techniques have become important pre-processing tool for digital vision processing applications. It has been shown in this paper that the image enhancements have been successfully used for improving the quality of poor images by using the various linear and non-linear techniques. This paper has evaluated the performance of dominant brightness level based image enhancement technique. The design and implementation has been done in MATLAB using image processing toolbox; the comparison among the dominant brightness level, histogram equalization and the adaptive histogram equalization has shown that the dominant brightness level outperforms over the histogram based image enhancement. In near future we will modify the dominant brightness level based image enhancement by using the adaptive histogram stretching as a post processing technique.

REFERENCES


