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COMPARISON OF ORIGINAL IMAGE ENHANCEMENT USING MULTIPLE HISTOGRAM TECHNIQUES

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Abstract: *There are different techniques for enhance an image by using gray scale manipulation, histogram equalization and filtering. Out of different enhancement techniques HE became a popular technique because, it is simple and effective. For preserving the input brightness of the image, there is a segment to avoid the generation of non-existing artifacts in the output image. So, these methods are used for preserving the input brightness with the significant contrast enhancement. They may produce an image which is not look like input image. HE method is used for re-mapping of the gray level and tends to introduce some annoying artifacts and unnatural enhancement. To preserve from these drawbacks brightness preserving techniques are used such as CLAHE, DSIHE and DHE. Image enhancement comparative analysis with the different techniques is carried out. In this comparison some subjective and objective parameters are used. For subjective parameter visual quality and computation time and for objective parameter PSNR, AMBE and MSE are used.*

Key Words – contrast enhancement, HE, PSNR, MSE, AMBE, visual quality.

1. INTRODUCTION

Human used five senses to perceive their environment – touch, smell, hearing, sight and taste. Out of these senses, sight is most powerful receiving and analyzing an image. In fact, more than 99% activity of the human brain is involved processing of the image from the visual cortex.

Image Enhancement [13]-Image enhancement is the technique in the image processing to improve an image in some senses according to the requirement, for increasing and decreasing the contrast of the image and for

Increasing and decreasing the brightness of the image. It is also important for bring out the details that are hidden in the image. Whenever an image is converted from one form to another form (such as in digital), there are some degradation in the image which can be removed by the image enhancement.

An example for the image enhancement is shown in figure 1, in which when we increase the contrast of an image and filtered it to remove the noise then it looks better.

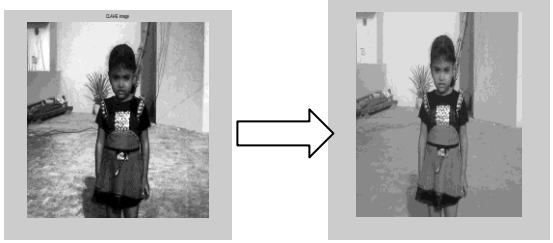

Figure 1: This enhancement can be achieved by different technique for image enhancement.

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a) **Adaptive Histogram Equalization method:-**
Adaptive histogram equalization is an extension to the traditional HE. It provides the solution for a problem of display devices to depict the full dynamic intensity range in some images (medical). Unlike HE, which operates on the entire image, it operates on the small regions (tiles) of the image. In this method, there is enhancement of the tiles rather than full image. So that, there is no so much difference between the input histogram and output histogram. The neighboring tiles are than combined by using bilinear interpolation in order to remove artificially induced boundaries.

b) **Dualistic sub-image histogram equalization method:-**Some enhancement technique, change the luminance of the image significantly with the equalization, so it never be utilized in the video system. DSIHE technique for the enhancement is decomposed an image into two equal area sub-images on the bases of its gray level probability distribution function. Then, these two images are taken in the equalization process respectively. Then, after the enhancement these two sub-images are composed into one image. Finally, result of the enhancement provides a enhanced image with its original luminance that make it possible to be used in video system directly.

c) **Dynamic histogram equalization for image contrast enhancement: -** DHE technique over the DHE performs the enhancement of the image without making any loss of the details in it. Before the equalization process, DHE partition the image on the basis of local minima and assign each partition a specific gray level range. Then, these partitions go from the repartitioning process until there are some dominating portion is present in it. Overall a better contrast enhancement is possessed by DHE with controlled dynamic range of gray levels and eliminating the possibility of low histogram component being compressed that may cause some part of image to have washed out performances.

2. BACKGROUND

Out of the many applications, the one of the first application of the digital image was in news paper industry, when a picture was sent by submarine cable between London and New York. In 1920, Bartlane cable picture transmission system reduced the time required to transport a picture across the Atlantic in three hours instead of a week. Specialized printing equipment coded the picture for cable transmission and then reconstructed it at receiving end. Some of the initial problems [2] in improving the visual quality of these early digital pictures were related to the reduction of printing procedures and to the distribution of the intensity levels. Because of the absence of the digital computer o that time, they were not considered digital image processing results. So history of the digital image processing is tied with the history of the digital computer. Because of the requirement of the high storage and computation power for digital image, digital image processing has been dependant on the development of the digital computer and supporting technique that include data storage, display and transmission.

3. IMPLEMENTATION

Compare the CLAHE, DSIHE and DHE technique with the measuring of some subjective and objective parameter:

3.1 Contrast Limited Adaptive Histogramequalization method [9]:-

Algorithm Steps: As shown in figure 2 the algorithm step for CLAHE is

1. In the first step, obtain all the inputs such as image, number of the regions in row and columns direction, clip limit for contrast limiting(normally from 0 to 1), number of bins for the histograms that used in building the image transfer function(dynamic range).
2. In second step, determine the clip limit if it is necessary, from the normalized value and than pad the image before splitting it into tiles.
3. In third step, taking a single tile from the image and make a histogram of this by using specified no. of bins. Clip the histogram by using clip limit and creating a mapping (transfer function) for this region.
4. In the last step, taking the cluster of four neighboring transfer function (mapping) and overlap these mapping tiles. Then extract a single pixel and apply for mappings for that pixel and obtain output pixel; repeat this cycle over the entire image.

3.2 Equal area Dualistic sub-image histogram equalization method [3]:-

Algorithm Steps: Let us consider an input image X which is partitioned into two equal area sub-images X1 and X2 on the basis of median Xm. So we have X=X1 U X2. Here

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$X1 = \{X(i,j) \mid X(i,j) < Xm, ¥\ X(i,j) \epsilon X\}$
$X2 = \{X(i,j) \mid X(i,j) \geq Xm\ ¥\ X(i.j) \epsilon X\}$

It is obvious that sub-image X1 is composed by gray level of $\{X_0, X_1, X_2 \ldots\ldots Xm\text{-}1\}$ and sub-image X2 is composed by gray level of
$\{Xm, Xm+1 \ldots\ldots\ldots XL\text{-}1\}$
Then the normalized gray level PDF for both the sub images is
$\{Pi / P, \quad i = 0,1,2,3\ldots\ldots e\text{-}1\}$ and

$\{Pi / (1\text{-}P) \quad i = 0,1,2\ldots\ldots L\text{-}1\}$

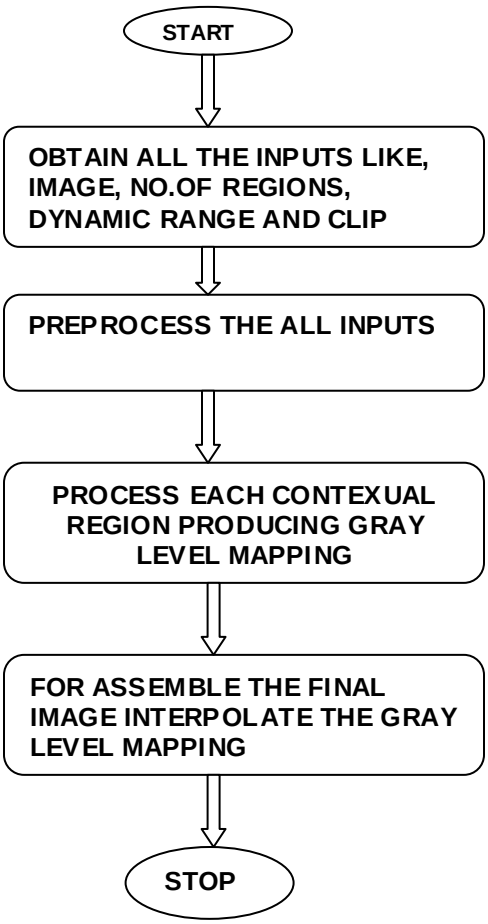

Figure 2: [CLAHE]

So the corresponding CDF is

$C_1(X_k) = \frac{1}{p} \sum_{i=0}^{k} pi \quad ,k=0,1,\ldots\ldots\ldots e\text{-}1$

$C_2(X_k) = \frac{1}{p-1} \sum_{i=e}^{l-1} pi, \quad k=e, e+1,\ldots\ldots L\text{-}1$

Based on the CDF function, the transfer function, for the two sub-images' histogram equalization are

$F_1(X_k) = X_0 + (X_{e-1} - X_0)\, c(X_k),\ k=0,1,\ldots e\text{-}1.$

$F_2(X_k) = X_e + (X_{l-1} - X_e)\, c(X_k),\ k=e, e+1,\ldots\ldots\ldots L\text{-}1$

For the final result of DSIHE, two sub-images are composed into one image. Suppose Y denote the processed image, then
$Y = \{Y(i, j)\} = F_1(X_1) \cup F_2(X_2)$

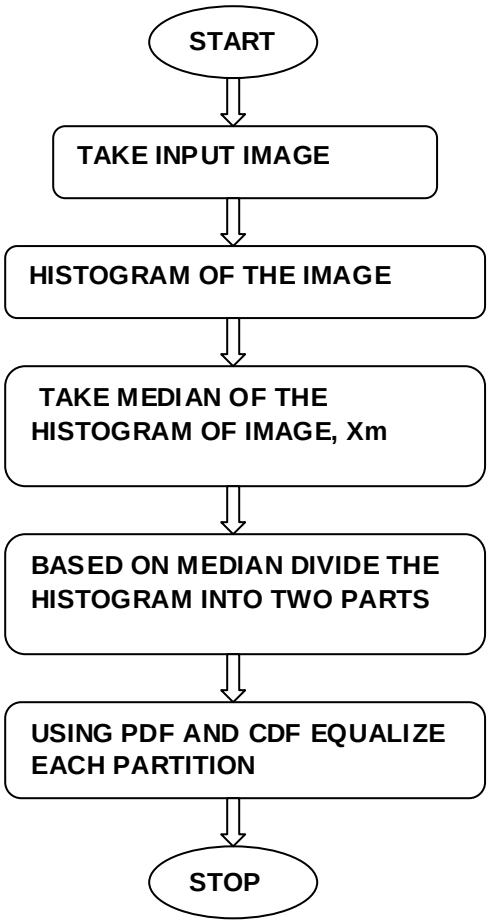

Figure 3: [DSIHE**]**

3.3 DYANAMIC HISTOGRAM EQUALIZATION METHOD [5]:-

Algorithm steps: In this method, our observation is to eliminate the domination of higher histogram components on lower histogram components in the

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image histogram and to control the amount of stretching of gray levels for reasonable enhancement of the image feature. This technique mainly contains three parts- histogram partition, gray level allocation and histogram equalization. The steps are:

1) In the first step take an image as an input.
2) Then make a histogram for this image.
3) Gaussian filter is used for smoothing the histogram. This smoothing filter of

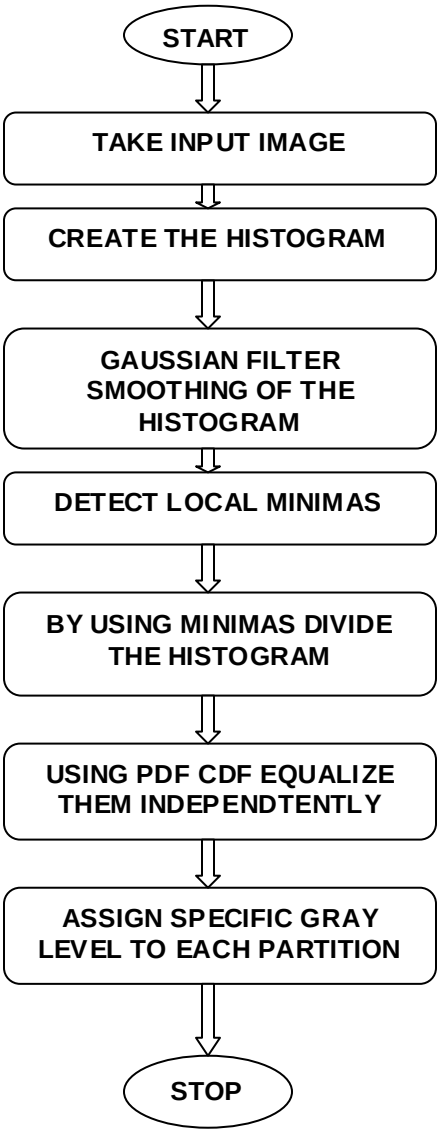

Figure 4: [DHE**]**

Size 1X3 on the histogram to get rid of insignificant minima. Then it takes sub-histogram that falls between two local minima (the first and last non-zero histogram components are consider as minima). Mathematically, if we have n number of gray level then we have n+ 1 local minimum in the histogram. Then, the first sub histogram take the histogram component of the GL range [n0.n1] and the second one will take [n1+1, n2] and so on. This provides some relaxation from the domination.

Further, for avoiding the domination, we first find the mean, μ, and standard deviation, σ, of the GL frequencies (histogram components) of each sub histogram regions. Then find the frequency between the (μ-σ) and (μ+σ) and if it becomes more than 68.3% of the total frequency of all GLs of that sub histogram than we can consider it non-dominating portion. Otherwise, between these points again apply the same process. The whole histogram of the image is make domination free with this process.

3) It may not assure a very good enhancement after the second step because some sub histogram having higher values may stretch too much leaving less room for other having lower histogram values to get significant contrast enhancement.

So, for each sub histogram, DHE allocates a particular range of GLs over which it may span in output image histogram. This is decided mainly based on the ratio of the span of gray levels that the sub histograms occupy in the input image histogram.

$$Span_i = m_i - m_{i-1}$$

$$range_i = (Span_i / \sum Span_i) * (L-1)$$

$Span_i$ is the dynamic GL range used by sub histogram i in input image. m_i is the ith local minima in the input image histogram. $range_i$ is the dynamic GL range for sub histogram i in output range.

4) Find the value of PDF and CDF independently

5) After the equalization of each sub histogram, span in the output histogram is allowed to confine within the allocated GL range that is designated to it. Therefore any portion of the input image histogram is not allowed to dominate in HE.

3.4 PARAMETERS:

PEAK SIGNAL TO NOISE RATIO (PSNR):

It is the evaluation standard of the reconstructed image quality, is the most wanted feature [10]. PSNR is measured in the decibels (dB) and it is given by

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$$PSNR = 10\log\left(255^2/MSE\right)$$

Where the value 255 is the maximum possible value that can be attained by the image signal. Mean square error is defined as where M*N is the size of the original image. Higher the PSNR value betters the reconstructed image.

ABSOLUTE MEAN BRIGHTNESS ERROR:
It is the difference between the brightness of the original image and enhanced image [6]. It is given by
AMBE = | E (x) – E (y) |

Where E(x) is the average intensity of the input image and E(y) is the average intensity of enhanced image.

CONTRAST: It defines the difference between the lowest intensity level and highest intensity level. Higher the value of contrast means more difference between the lowest and highest intensity level.

VISUAL QUALITY: With the taking a look at the enhance image, anyone can easily determine the difference between the input image and enhance image and hence, performance of the enhancement technique is evaluated.

TOOL TO BE USED: In this implementation of the different enhancement technique MATLAB 7.6 is used. From it image processing toolbox is used. Mat lab is a high performance language for technical computing. It integrates computation, visualization and programming in easy to use environment where problem and solution are expressed in familiar mathematical notation.

4. EXPERIMENTAL RESULTS

For getting the results that which technique is giving the best enhancement result, out of the three histogram equalization technique CLAHE, DSIHE and DHE, algorithm of each technique for finding the different parameters is used and get the best technique for the different gray scale image.

5. IMPLEMENTATION

Result for 'girl' image is

5.1 CONTRAST OF GIRL IMAGE:
Figure 5 show the original image and enhanced image with the three different techniques CLAHE, DSIHE and DHE. We can see the difference in the contrast of the image with the different technique.

Figure 5: [ORIGINAL IMAGE**]**

Figure 6: [CLAHE IMAGE**]**

Figure 7: [DSIHE IMAGE**]**

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Figure 8: [DHE IMAGE**]**

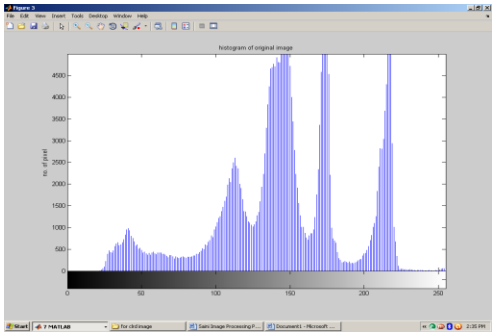

Figure 9: [ORIGINAL HISTOGRAM**]**

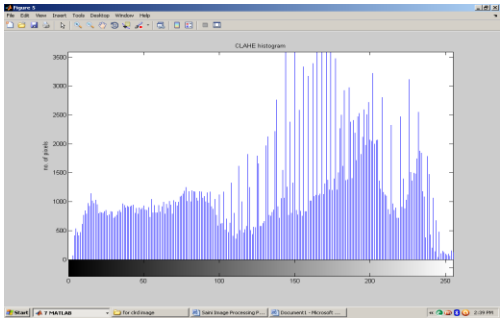

Figure 10: [CLAHE HISTOGRAM**]**

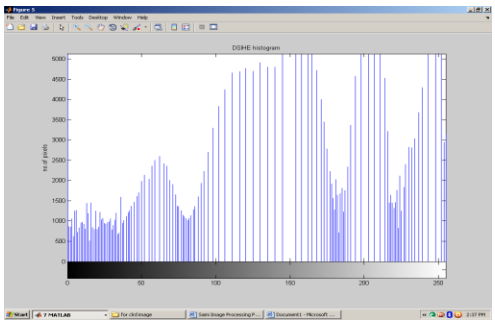

Figure 11: [DSIHE HISTOGRAM**]**

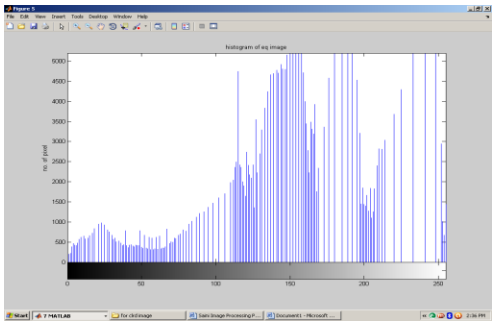

Figure 12: [DHE HISTOGRAM**]**

5.2 HISTOGRAM OF THE IMAGE:

Figure 6 show the histogram result from the original image and different enhancement technique of histogram equalization, CLAHE, DSIHE and DHE.

5.3 PARAMETER VALUE:

Table-1 value defined the different value for the different technique, which provides us the comparative analysis for these HE techniques.

Table 1

PARAMETER COMPARISSION TABLE . FOR GIRL IMAGE

	PSNR	AMBE	CONTRAST
CLAHE	27.6225	4.3047	19.5390
DSIHE	27.7145	7.3529	30.9912
DHE	32.8466	-3.2544	09.6706

6. RESULTS

We can see from the result of the figure-5, figure-6 and from the table-1 as

1) Figure-5 show the visual quality of the DHE enhance image is better as compare to CLAHE and DSIHE technique.
2) As we know the value of AMBE should be low, table value defined that the AMBE value for the DHE is lower as compare to others,

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3) Contrast value should be minimum, which is for the DHE technique in the table as compare to the others technique.
4) Value for the PSNR should be high; again from the table we can see the value for the DHE is better.

At last, from all the measurement we concluded that from the all of three HE enhancement techniques DHE gives the better result.

6.1 RESULTS FOR THE 'BIKE' PICTURE:

Same procedure is followed for another grayscale image 'cameraman.tif" and finds the result. Again with the overall comparison DHE enhancement technique is better as compare to the CLAHE and DHE enhancement technique. Finally, we got the result that out of these HE enhancement techniques DHE gives the better result as compare to the CLAHE and DHE.

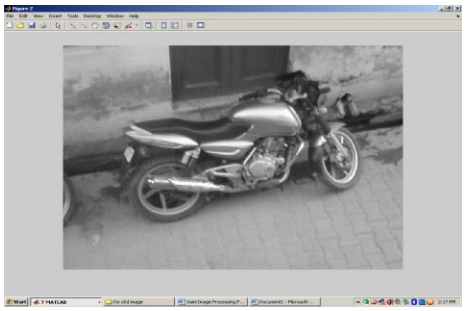

Figure 13: [ORIGINAL IMAGE**]**

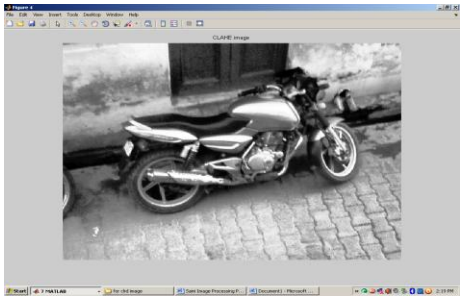

Figure 14: [CLAHE IMAGE**]**

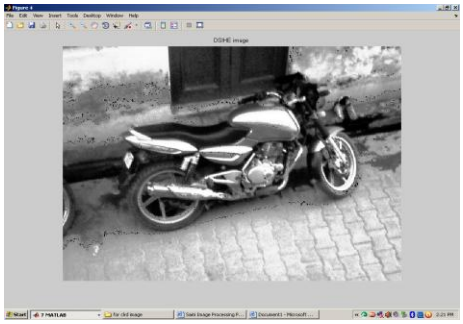

Figure 15: [DSIHE IMAGE**]**

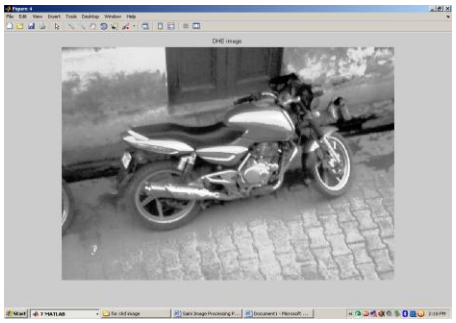

Figure 16: [DHE IMAGE**]**

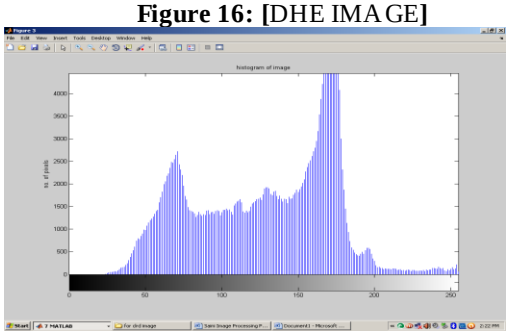

Figure17: [ORIGINAL HISTOGRAM**]**

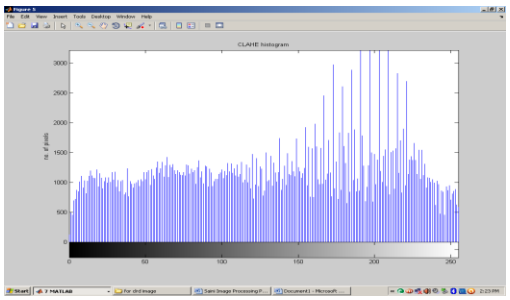

Figure 18: [CLAHE HISTOGRAM**]**

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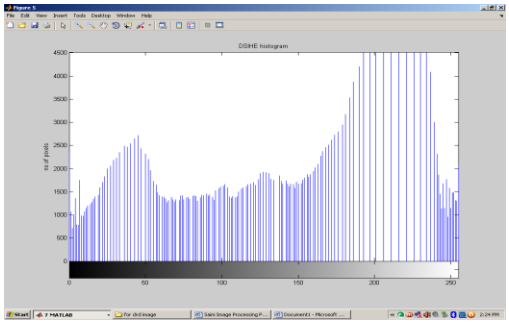

Figure 19: [DSIHE HISTOGRAM**]**

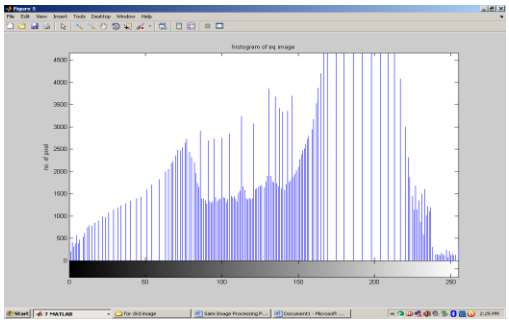

Figure 20: [DHE HISTOGRAM**]**

6.2 PARAMETER TABLE:

Table-2

PARAMETER COMPARISSION TABLE FOR BIKE IMAGE			
	PSNR	**AMBE**	**CONTRAST**
CLAHE	28.560	-4.211	25.027
DSIHE	28.580	-5.352	29.472
DHE	35.507	-6.794	10.247

7. CONCLUSION AND FUTURE SCOPE:

In this Paper, a frame work for image enhancement based on prior knowledge on the Histogram Equalization has been presented. Many image enhancement schemes like Contrast limited Adaptive Histogram Equalization (CLAHE), Equal area dualistic sub-image histogram equalization (DSIHE), Dynamic Histogram equalization (DHE) Algorithm has been implemented and compared. The Performance of all these Methods has been analyzed and a number of Practical experiments of real time images have been presented. From the experimental results, it is found that all the three techniques yields Different aspects for different parameters. In future, for the enhancement purpose more images can be taken from the different application fields so that it becomes clearer that for which application which particular technique is better both for Gray Scale Images and color Images. Particularly, for color images there are not many performances measurement parameter considered. So, new parameters can be considered for the evaluation of enhancement techniques. New colour models can also be chosen for better comparison purpose. Optimization of various enhancement techniques can be done to reduce computational complexity as much as possible.

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