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Comparison of Different Enhanced Image Denoising with 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. But after the enhancement some noise is also there which is further reduce for better result. Enhanced Image Denoising 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 and MSE are used.

Index Terms— Contrast enhancement, HE, PSNR, MSE, visual quality .

I. 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.

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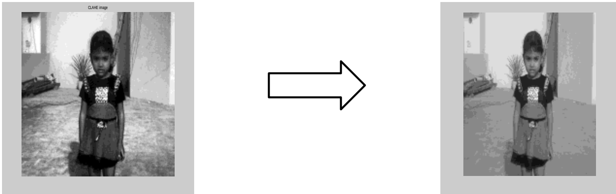

FIGURE – 1

This enhancement can be achieved by different technique for image enhancement.

A. Adaptive Histogram Equalization Method [9]

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)[7]. 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[9].

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[6]. 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 HE, 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[12]. 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.

D. Wavelets thresholding

De-noising can be accomplished using thresholding technique using a Daubechies wavelet order 4. The single trial was decomposed at level 5 and the detail coefficient were soft threshold [15],[16].

Donoho proposed what the wavelet community calls the universal threshold given by

$$T = \sqrt{2\log(M)\sigma_n}$$

Where M is the sample size and σ_n is the noise standard deviation. This technique has been recognized as a simple and efficient, but only when a single threshold is used globally . All wavelet filters use wavelet thresholding operation for de-noising. The basic procedure for all thresholding method is as follows.

Calculate the DWT of the image.

1) Threshold the wavelet coefficients

2) Compute the IDWT to get the de-noised estimate.

3) There are two thresholding function used, i.e. a hard threshold and a soft threshold.

The hard thresholding is described as

$$\eta_1(w) = w\, I\,(|W| > T)$$

Where W is the wavelet coefficient

T is threshold

The soft thresholding function is described

$$\eta_2(w) = (w - \text{sgn}(w)\, T)\, I(|W| > T)$$

The soft thresholding rule is chosen over hard thresholding [16].

II. 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.

Ref.[14] presents that among the entire digital image processing techniques image enhancement is simple and most appealing area. The main purpose of image enhancement is to bring out detail that is hidden in an image or to increase contrast in a low contrast image. Improvement in quality of these degraded images can be achieved by using application of enhancement techniques. Various enhancement schemes are used for enhancing an image which includes gray scale manipulation, filtering and Histogram equalization. In the different histogram equalization techniques, contrast limited adaptive histogram equalization is one of the well known image enhancement technique. But with the image enhancement, it can be possible that some noise is added in the final enhanced image. This image is further denoised with the wavelets denoising technique. This gives the satisfactory result for the denoising as compare to the denoising with the filters. In subjective parameters, visual quality and in objective parameters, Peak signal-to-noise ratio (PSNR), Mean squared error (MSE) is used.

III. IMPLEMENTATION

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

A. Contrast Limited Adaptive Histogram equalization method [9]

Algorithm Steps: 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 and then enhanced image is denoised using wavelets thresholding.

B . *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

X1= {X(i,j) | X(i,j) < Xm, ¥ X(i,j) є X }
X2= {X(i,j) | X(i,j) ≥ Xm ¥ X(i.j) є X }

It is obvious that sub-image X1 is composed by gray level of {X0, X1, X2……..Xm-1} and sub-image X2 is composed by gray level of
{Xm, Xm+1……….XL-1}
Then the normalized gray level PDF for both the sub images is

{Pi / P, i = 0,1 ,2 ,3……e-1 } and

{Pi / (1-P) i = 0,1,2…….L-1 }
So the corresponding CDF is

C1(Xk) = $\frac{1}{p}\sum_{i=0}^{k} pi$,k=0,1,……. e-1

C2(Xk) = $\frac{1}{p-1}\sum_{i=e}^{l-1} pi$, k=e,e+1,….. L-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,….e-1 .

$F_2(X_k)= X_e+(X_{l-1}-X_e)c(X_k)$, k=e,e+1,………..L-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) } = F1(X1) U F2 (X2)
Finally this enhanced image is denoised with the wavelets thresholding technique.

C. 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 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

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 minima 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.

Spani = mi-mi-1

rangei = (Spani / ∑Spani) * (L-1)

Spani is the dynamic GL range used by sub histogram i in input image. mi is the ith local minima in the input image histogram. rangei 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.

At last the enhanced image is denoised with the wavelets thresholding technique.

IV. PARAMETERS

A. 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

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

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.

B. 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.

C. 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.

V. HISTOGRAM COMPARISION

Image Enhancement is defined as the technique in image processing to improve an image in same according to the requirement.
a) If the contrast of the image has to be increase, the gray value histogram is made almost equal distribution.
b) If the brightness of the image has to be increased, higher gray value of the image are made more in number that histogram concentrates on higher values of gray.
c) If the darkness of the image has to be increased, lower gray value of the image are made more in number that histogram concentrates on lower values of gray.
d) If the contrast of the image has to be decreased, the gray value histogram is made to be concentrated in the middle range of the gray value.

VI. TOOL TO BE USED

In this implementation of the different enhancement technique MATLAB 7.6 is used. From it image processing toolbox is used. Matlab 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.

VII. EXPERIMENTAL RESULTS

For getting the results that which technique is giving the best enhancement then denoising 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.

VIII. IMPLEMENTATION

Result for 'BIKE' image is This result show the visual quality with the different enhancement technique.

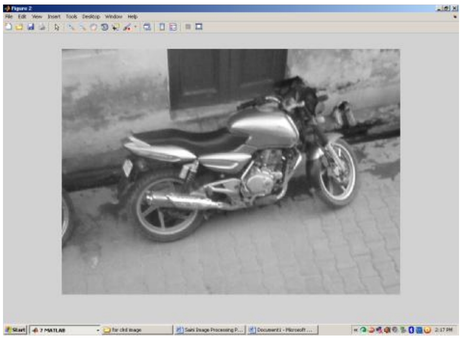

FIGURE-F.1 ORIGINAL IMAGE

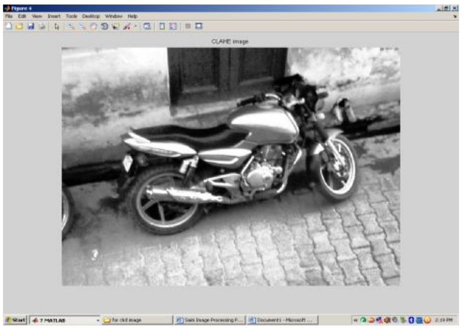

FIGURE-F.2 CLAHE IMAGE

FIGURE-F.3 DSIHE IMAGE

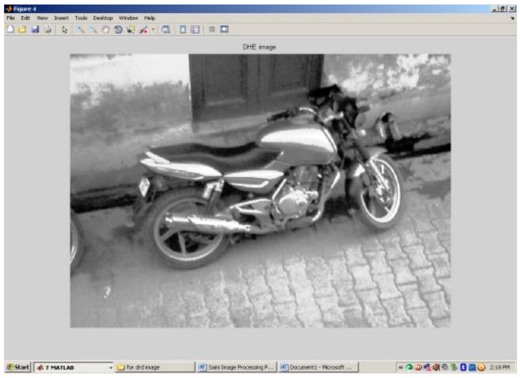

FIGURE-F.4 DHE IMAGE

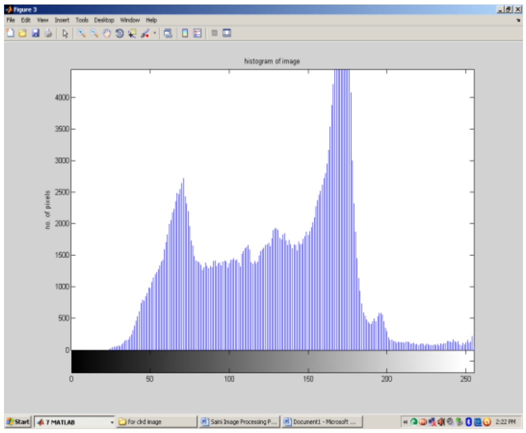

FIGURE-H.1 ORIGINAL HISTOGRAM

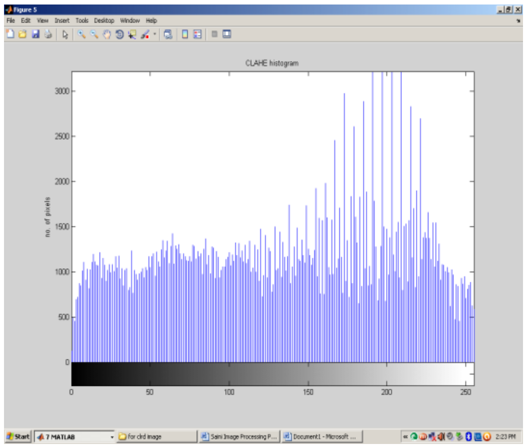

FIGURE-H.2 CLAHE HISTOGRAM

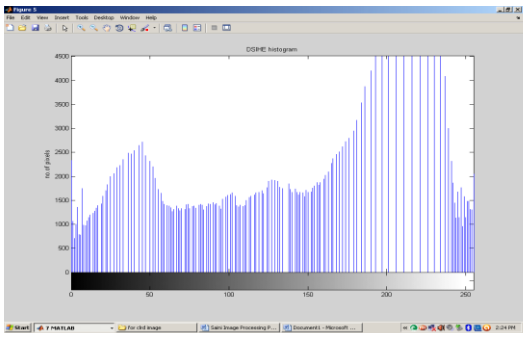

FIGURE-H.3 DSIHE HISTOGRAM

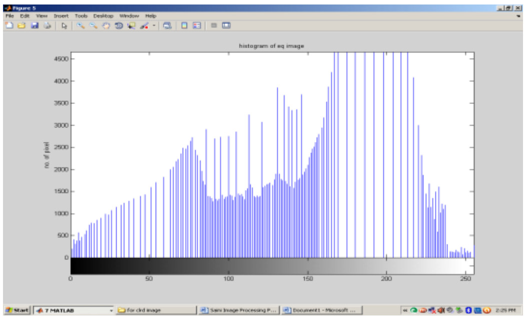

FIGURE-H.4 DHE HISTOGRAM

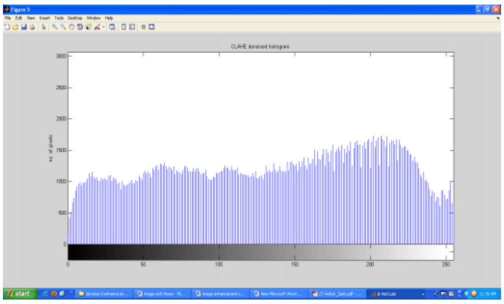

FIGURE-H.5 DENOISED CLAHE

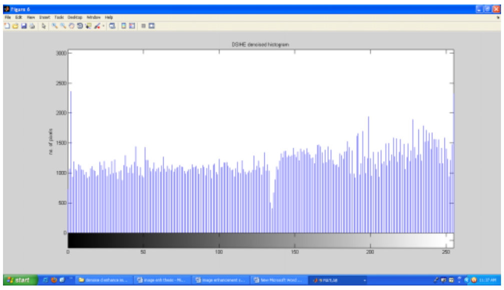

FIGURE-H.6 DENOISED DSIHE

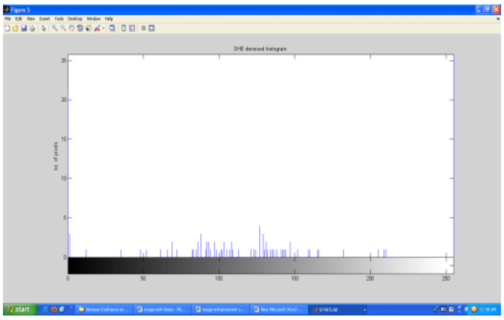

FIGURE-H.7 DENOISED DHE

With the help of the Histogram figure (figure-H)

It can be concluded that the some noise is present after the enhancement which is then reduce shown in figure of histogram.

Table-1

Parameter	PSNR	Contrast	PSNR2	CONTRAST2
CLAHE	28.5608	25.0274	48.6902	0.0384
DSIHE	28.5800	29.4725	49.2176	0.0545
DHE	22.5866	1.1728	38.1992	0.1848

Now comparing the results for PSNR and CONTRAST for both the condition that is before the denoising PSNR and after the denoising PSNR2 having the best results for every technique. We can also compare with the contrast value also.

IX. CONCLUSION AND FUTURE SCOPE

In this paper, a frame work for denoising the enhanced image 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 after the denoising using the wavelet thresholding.

The Performance of all these Methods with the denoising 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 with the denoising yields Different aspects for different parameters.

In future, for taking the better result of the enhanced images different enhancement and denoising technique can be taken in the different application fields so that it becomes clearer that for which application which particular technique is better with the denoising for both Gray Scale Images and colour Images. Particularly, for colour images there are not many performances measurement parameter considered. So, new parameters can be considered for the evaluation of enhancement techniques and then denoising. New colour models can also be chosen for better comparison purpose. Better will be result after the enhanced image denoising gives the satisfactory and usual information about the images.

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