iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5340

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Image Enhancement using CLAHE-DWT Technique

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Abstract: Image restoration is an important issue in high level image processing which deals with recovering of an original and sharp image using a degradation and restoration model. During image acquisition process degradation occurs. Image restoration is used to estimate the original image from the degraded data. Aim of this project is to use Combination of contrast limited adaptive histogram equalization(CLAHE) and discrete wavelet transform(DWT) for image enhancement and to compare the original image with reconstructed_image(enhanced_image)using MSE,PSNR parameters.
Keywords: Image_restoration, CLAHE, DWT, Image enhancement, MSE, PSNR.

I. INTRODUCTION

The contrast enhancement, as a kind of significant processing technique for both images and videos, can effectively improve the image visual quality for human perception and recognition. In addition, it is also an important preprocessing step to accentuate the essential features in images and videos for automatic pattern recognition, machine vision and other applicationsImages are produced to record or display useful information or details .Due to flaws in the imaging and capturing process, however, the recorded image always represents a degraded version of the original scene. The undoing of these imperfections is critical to many of the successive image processing tasks .There exists a huge range of different degradations, which should be taken into account, for example noise, geometrical degradations, illumination and color imperfections (under-exposure/over-exposure, saturation) and blur. The area of image restoration (sometimes referred to as image deblurring or image deconvolution) is concerned with the reconstruction or estimation of the uncorrupted image from a blurred and noisy image. Essentially, it tries to perform an operation on the image which is the inverse of the imperfections in the image formation system. In the use of image restoration methods, the characteristics of the degrading system and the noise are assumed to be known from before. In practical situation, however one may not be able to obtain this information directly from the image formation process. The aim of blur identification is to determine the attributes of imperfect imaging system from the observed degraded image itself prior to the restoration process. In functional circumstance, be that as it may one will be unable to get this data straightforwardly from the picture development process. The point of obscure ID is to decide the traits of defective imaging framework from the watched corrupted picture itself preceding the rebuilding procedure. The term digital image refers to processing of a two-dimensional picture by a digital computer. In a broader context, it implies digital processing of any two-dimensional data. A digital image is an array of real or complex numbers represented by a finite number of bits. An image given in the form of a transparency, slide, photograph or an X-Ray is first digitized and stored as a matrix of binary digits in computer memory. This digitized image can then be processed and/or displayed on a high-resolution television monitor. For display, the image is stored in a rapid-access buffer memory, which refreshes the monitor at a rate of 25 frames per second to produce a visually continuous display.

II. RELATED WORKS

In this section, we provide a brief review of the previous work which is related to the proposed CLAHE-DWT, that is, CLAHE. CLAHE is a classic local contrast enhancement technique which can enhance the local details of image effectively. The main steps of CLAHE are given as follows:

Step 1: Separate the image into tiles which are continuous and non-overlapped.

Step 2: Clip the histogram of each tile above a threshold and distribute the clipped pixels to all grey levels evenly.

Step 3: Apply HE on each tile.

Step 4: Interpolate the mapping between neighboring tiles. The resulting mapping at any pixel is interpolated from the intensity mappings of four neighboring tiles [10].CLAHE clips the part of histogram above a threshold and redistributes the clipped pixels to each grey level. This operation can alleviate the noise enhancement phenomenon in some degree.However, the noise is still unacceptable for some applications. What is more, it may lose details in some portions of the input image because of over enhancement.

III. CLAHE-DWT ALGORITHM

A new method based on the usage of CLAHE-DWT is proposed in this project. In this section, we first give the main steps of our proposed CLAHE-DWT. To make it more understandable, we then further explain the DWT and weighting operation in our proposed method. CLAHE is a classic method for enhancing the local contrast of an image, but it faces the over-enhancement and noise enhancement problems in some portions of the image. To overcome these problems, we propose a novel image enhancement method, that is, CLAHE-DWT which combines CLAHE with DWT

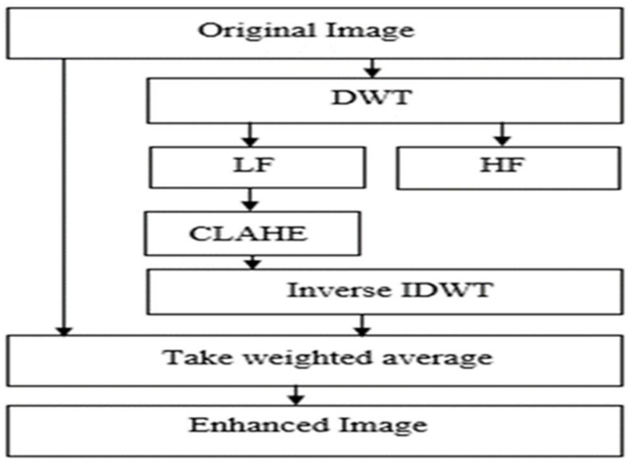

Fig. 1 Flowchart of CLAHE-DWT

A. The procedures of the CLAHE-DWT is given as follows

Step 1: Decompose the initial image into low-frequency and high-frequency elements by N-level DWT using Haar wavelet. The Haar wavelet is simple and thus suitable for hardware implementation. The choice of parameter N is discussed in detail later.

Step 2: Enhance the low-frequency coefficients using CLAHE and keep the high-frequency coefficients unchanged.

Step 3: Reconstruct the image by inverse DWT of the new coefficients. Finally, take the weighted average of the reconstructed and original images. The originally proposed weighting coefficient makes the regions with different luminance's enhanced appropriately and thus reduces over-enhancement effectively**.**

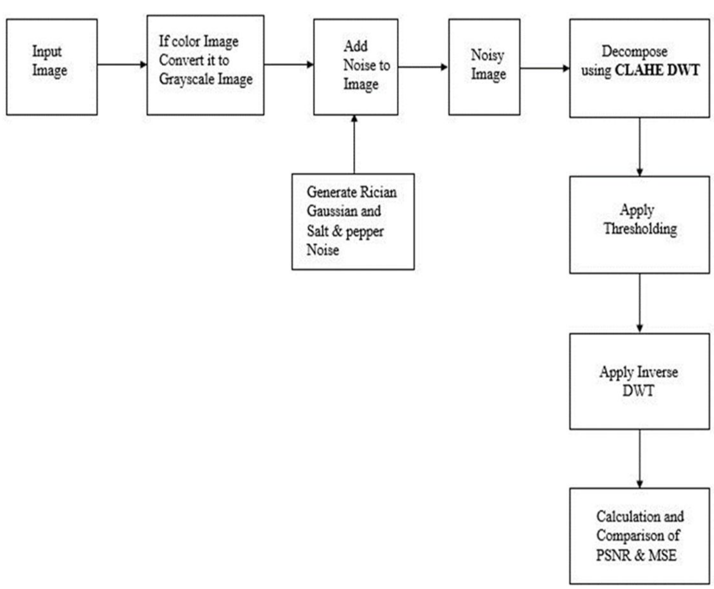

Figure 2: Block Diagram

Let us consider an input image which needs to be enhanced. Image is read into MATLAB using imread"command(image_name.jpg).Image obtained by digital camera is in RGB format but for preprocessing and post processing, image is needed to be converted into gray scale. This makes processing simple and easier. Noise is added to the image to know the performance of denoising algorithm. In our project we have made use of Rician Gaussian and salt and pepper noise. The noisy image is decomposed using CLAHE-DWT technique.Thresholding is applied to the decomposed image. After thresholding, perform IDWT to obtain reconstructed image.Finally, the reconstructed image is compared with original image using MSE and PSNR parameters.

B. Clahe

Contrast Limited AHE (CLAHE) differs from ordinary adaptive histogram equalization in its contrast limiting. This feature can also be applied to global histogram equalization, giving rise to contrast limited histogram equalization (CLHE), which is rarely used in practice. In the case of CLAHE, the contrast limiting procedure has to be applied for each neighbourhood from which a transformation function is derived. CLAHE was developed to prevent the over amplification of noise that adaptive histogram equalization can give rise to. It is achieved by limiting the contrast enhancement of AHE. The contrast amplification in the vicinity of a given pixel value is given by the slope of the transformation function. It is proportional to the slope of the neighbourhood cumulative distribution function (CDF) and therefore to the value of the histogram at that pixel value. CLAHE limits the amplification by clipping the histogram at a predefined value before computing the CDF. This limits the slope of the CDF and so of the transformation perform. The value at that the bar graph is clipped, the supposed clip limit, depends on the standardization of the bar graph and thereby on the scale of the neighbourhood region. It is advantageous to not discard a part of the bar graph that exceeds the clip limit however to spread it equally among all bar graph bins.

C. DWT

In past decades, wavelet transform has been widely employed in image processing, which decomposes an image into a multi-resolution sub band structure through a two-channel filter bank. The multi-resolution decomposition of the image is formed by repeatedly implementing low-pass filter, high-pass filters and down-sampler to the image in the horizontal and vertical directions [20,21].Fig.3is the illustration of one-level DWT decomposition using Haar wavelet.

(a) (b)

Figure 3:(a)original image (b)level 1 dwt(LP,HP)

Figure 3(c)shows the four sub-band images.Level 2 dwt

To limit the enhancement of noise and avoid Overemphasis of detail information, the high frequency components are kept unchanged and only the low-frequency component is enhanced by CLAHE in our proposed CLAHE-DWT.

IV. EXPERIMENTAL RESULTS

The proposed CLAHE-DWT algorithm is used to enhance the given input image and the enhanced output image is compared with input image using MSE,PSNR parameters.

(a) (b)

Figure 4:(a)original image (b) equalized output image

To compare these image enhancement methods quantitatively, two objective evaluation indexes, that is MSE(mean squared error)and peak signal to noise ratio (PSNR)are used.

A. *Mean Square Error (MSE)*

It defines the square of error between original image and stego image

$$\text{MSE}=10\log_{10}\sum_{n=0}^{N}[x(n)-y(n)]^2$$

Here x(n) represents input image and y(n) represents enhanced or reconstructed image.

B. *Peak Signal to Noise Ratio (PSNR):*

It measures the quality of image. PSNR compare the original image with stego image. PSNR is measured in decibels (db).

$$\textbf{PSNR}= \mathbf{10log_{10}}\frac{256^2}{MSE}$$

COMPARISON PARAMETERS	VALUE
MSE	0.02
PSNR	66.13 dB

Table 1: Comparison parameters.

V. CONCLUSION AND FUTURE SCOPE

A. *Conclusion*

Histogram equalization (HE) based Contrast Limited Adaptive Histogram Equalization CLAHE [5] improves the contrast and conjointly preserves the brightness and entropy as a result of method maximizes entropy. This methodology not solely provides flat histogram however conjointly enhances image distinction. The projected CLAHE-DWT algorithmic rule has been used to method many gray and color pictures. The performance of the AHE. CLAHE-DWT, which combines CLAHE with DWT. In the proposed methodology, image is divided into low-frequency and high-frequency parts by DWT. The low-frequency component stands for the approximation info of the input image. The high-frequency part contains most noises and every one the detail info of image. To limit the noise improvement and protect the detail info from over-enhancement, only the low-frequency part is increased and therefore the high-frequency component is unbroken unchanged. Finally, take weighted average of the reconstructed and original

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images by employing a weight issue matrix to alleviate over-enhancement more. Experimental results demonstrate that the performance of planned methodology is impressive whereas will depress noise and avoid over improvement.

B. Future Scope

Image enhancement using CLAHE-DWT is time consuming since it enhances pixel by pixel but not the entire image. Its complex on hardware. Its performance is sequential. In future all these disadvantages can be reduced or overcome by making use of different wavelets and methodologies.

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A. Text book

Digital image processing by GONZALES.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com