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Detail image Enhancement Survey

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Abstract **-** Image enhancement plays important role in the field of image processing. Many images suffer from poor contrast and noise. There is requirement of enhancing the contrast& removing noise to improve image quality. Image enhancement is the process of improving quality of image. Image enhancement produces the image which will give better result than original image. Detail image enhancement is introduced in the field of image processing to solve many problems like blurring, ringing, unnaturalness etc. Detail image enhancement algorithm first decompose source image into a base layer and detail layer via edge preserving smoothing algorithm and amplify detail layer to produce to detail enhanced image. Analysis of different methods of image enhancement is carried out. Existing image enhancement techniques have some drawbacks. The objective of this paper is to determine limitation of the existing image enhancement techniques.

Keywords **-** *Image enhancement, Histogram Equalization, Adaptive Histogram Equalization, Bilateral filtering, Weighted least squares, Lo gradient minimization.*

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I. INTRODUCTION

Image enhancement is the process of improving quality of image to give better visual appearance. Image enhancement has various applications in the field of image processing. Image enhancement process simply highlights certain features of an image.

Detail image enhancement is required due to many problems in the field of image processing. Detail image enhancement is widely used image editing tool. Most of the detail image enhancement algorithms are based on edge preserving decomposition algorithm. A source image is decomposed due to into base layer & detail layer via the edge preserving decomposition algorithm. Then detail image enhancement is produced by amplifying detail layer.

There is various techniques are available for image enhancement. Some of them are introduced in this paper. Histogram Equilization[1]-[2] is used to enhance contrast of image. It is practically straightforward method and invertible operator. Adaptive histogram equilization[5] it reduce the problem of poor brightness in image. Bilateral filtering [4] combine range filter with domain filter to preserve edges. Weighted least square (WLS) [6] based multi scale decomposition algorithm decomposes images into two layer by solving optimization problem. Lo norm gradient minimization [8] was used in smoothing terms. It preserves edges better than WLS

These methods are explained in next section .observation of these methods are summarized in section III. paper is concluded in section IV.

II. IMAGE ENHANCEMENT TECHNIQUES

Image enhancement is required to enhance contrast of image and to remove noise. Image enhancement process consists of various techniques to improve image quality for specific applications.

A. Histogram Equilization [HE]

Basic idea of HE method is to remap gray levels of an image. Histogram is the graphical representation of allocation of data Histogram Equilization [HE] is the common method used for improving contrast of digital images. Histogram Equilization [2] is the image enhancement techniques to enhance the appearance of images. Consider predominantly dark images..then its histogram skewed towards lower end of gray scale & image detail compressed into dark end of histogram. then stretching out gray level at dark ends result in much clearer image. Suppose X is a given image then the probability density functionn $P(X_k)$ is defined as

$$P(X_k) = \frac{n^k}{n} \quad (1)$$

for k= 0,1,.....L-1.

Where

n^k - no. of times that level X_k appears 'n' input images

n - Total no. of samples in input image.

Based on PDF the commutative density function is defined as

$$C(X) = \sum_{j=0}^{k} P(xi) \quad (2)$$

Transform function f(x) based on cumulative density is defined as

$$f(X)=X_0+(X_{L-1} - X_0)\, C(X)$$

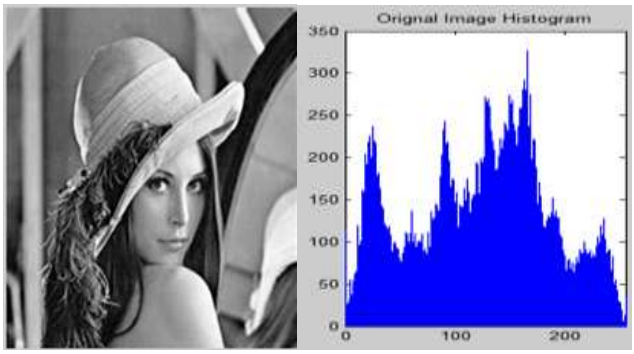
Then output image of HE,
Y=P{Y (i,j)} can be expressed as

$$Y = f(x) = \{f(X(i,j)| \forall X(i,j) \in X\} \quad (3)$$

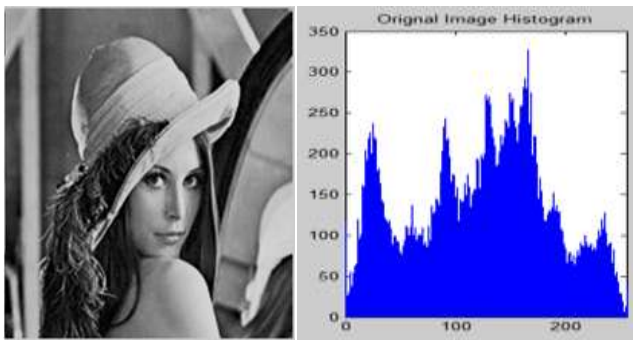
HE flattens the histogram. Base of information theory, entropy of message source will get the maximum value when message has uniform distribution property [3] A

significant change in the brightness of an image can be introduced by HE.

Histogram Equilization [HE] is commonly used image enhancement techniques due to its simplicity & its better performance for all types of HE trends to introduce gradient reversal artifacts and unnatural enhancement. Other Histogram Equilization techniques[9] have been proposed. These are Brightness Preserving Bi-Histogram Equilization, Dualistic Sub-Image Histogram Equilization, Minimum mean brightness error Bi-HE, Recursive Mean-Separate HE Method, Mean Brightness Preserving Histogram Equilization, Dynamic Histogram Equilization, Brightness Preserving Dynamic Histogram Equilization.



a.Original Image



b.Output Image

Fig.1.Result of Recursive Mean-Separate HE Method

Recursive Mean-Separate HE Method [9] is extended version of Brightness Preserving Bi-Histogram Equilization (BBHE). In this method instead of decomposing image only once, it performs decomposition recursively. Original image histogram is divided into subhistograms, computing the HE, then after mapping we will get output image.Fig.1 shows result of Recursive Mean-Separate HE Method.

B. Adaptive Histogram Equilization [AHE]:-

Adaptive Histogram Equilization [HE] produces superior images. It is automatic, reducible & locally adaptive. Histogram Equilization [HE] consider global content of image for enhancement. Histogram Equilization [HE] highlights the border and edges but reduces the local details. Due to this over enhancement saturation artifacts are produced. To remove such drawbacks the improved Histogram Equilization i.e. Adaptive Histogram Equilization [AHE] is required.

Adaptive Histogram Equilization [AHE][5] is the extension of Histogram Equilization [HE]. AHE is different from Histogram Equilization [HE] in the sense it computes several histograms from various small regions of image & then combines this histogram to get result image. It will overcomes the poor brightness.Combination of the subhistograms takes place using bilinear interpolation to eliminate artificially introduced boundaries.Adaptive Histogram Equilization gives better results than Histogram Equilization. In some cases we don't want overall contrast enhancement ,at that time Adaptive Histogram Equilization is applicable.Use of Histogram Equilization may causes overenhancement,which results in unnaturalness.

In Adaptive Histogram Equilization [AHE] contrast of an image is enhanced at smaller scale while it reduces at larger scale. Contrast limiting is takes place in AHE to avoid the amplification of noise it is done before Histogram Equilization [HE] the cumulative distribution of gray levels lower than all others.

C. Bilateral Filtering:-

Bilateral filtering outperforms linear filters in reducing halo artifacts near edges. Bilateral filter smooth's images while preserving edges .the function of traditional filter in its domain is performed in the range of an image is the idea behind the bilateral filtering concept. Traditional filtering is nothing but domain filtering which enforces closeness that fall off with distance. Similarly range filtering averages image values with weights that delay with dissimilarly. Special locality is important term. if only range filter is used it will distort the color map of image. So the combination of range of domain filtering is used. This combined filter is known as bilateral filtering [4].

Bilateral filtering is used successfully due to its various qualities. Its formulation is simple because each pixel is replaced by weighted average of its neighbors. it depends on size of contrast of the features to preserve. It is noniterative method. it can be computed at interactive speed even on large images. For color image if we use filter separately for three color bands then it will distort the color in result image. On the other hand Bilateral filter operate on three bands at once. Due to this an unexpected color combination artifacts is removed.

Advantage of Bilateral filtering are easy understanding, easy to adapt & easy to setup in the sense noniterative. Bilateral filtering has variety of applications denoising, texture & illumination separation tone mapping retinex & tone management, data fusion, 3D fairing. Other applications are dept map from luminance, video stylization, optical flow, unsampling etc.

Bilateral filtering in contrast with the standard filtering will produces no phantom colors along edges of color images and it reduces phantom colors in original image. Bilateral filtering in noniterative, local & simple.

D. Weighted Least Square [WLS]

Images are decomposed into base layer and detail layers. By applying edge-preserving smoothing operator to image the base layer is computed. Difference between original image and base layer gives detail layer. Manipulation of resultant layers takes place in various ways, and recombined to give final result. Computing base layer is called coarsening process. It must done carefully to avoid artifacts which caused during manipulation and recombination process. The ideal edge-preserving filter must neither blur nor sharpen the edges while smoothing the regions between such edges. But such operator does not exist. To produce multi-scale base-detail decomposition the operator must allow increasingly larger regions to become smoother.WLS operator shows more robustness & versatility. This operator is suited for progressive coarsening of images and for extraction of details. This operator is applicable to construct an edge-preserving multi-scale image decomposition, which plays important role in multi-scale HDR & LDR tone mapping, detail enhancement.etc.

Bilateral filtering trends to produce blur over more edges, which produces halo artifacts instead by applying weighted least square. Smoothing to same signal, it achieves both finer & coarser smoothing without introducing any artifacts while preserving step edges. The WLS framework perform debluring of images in presence of noise to reduce ringing[7].WLS based operator is robust & versatile & used in many operations that are based on BLF at longer computational time.WLS allows small feature to gracefully fade in magnitude without introducing significant blurring which causes halos.WLS formulation is related to unisotropic diffusion & iterated BLF.

WLS has variety of application [6] which shows its robustness & versatility. These applications are tone mapping, contrast manipulation, edge abstraction, detail exaggeration.

The WLS operator is suited for progressive coarsening of image and & for extracting detail & spatial. Thus it is used to construct an edge preserving multi-scale image decomposition.In image fusion process, Weighted Least Square optimization framework is used for weight map refinement.

E. Lo Gradient Minimization

Lo gradient minimization is applied to control the number of nonzero gradient. It reduces the small gradient associated to noise & preserves important features. Lo gradient Minimization aims to limit the no. of gradient transitions in output image. Lo smoothing algorithm is formulated as,

$$s^{min}\{\sum_P(\mathrm{Sp}-\mathrm{Ip})^2+\lambda*C(s)\} \quad (4)$$

Where 'S' is edge preserved smoothing image, I – input images, λ - lagrangian factor,

C(s) - Lo norms of gradient field & subscript p – pixel index of image. λ- Is used to adjust importance of two terms to control degree of enhancement.

After solving minimization problem S is obtained. I-S gives detail layer of input image. To get the detail enhanced image E an amplified detail layer is added to source image.

$$E= I+K * D \quad (5)$$

Detail layer is amplified K times.

This method has several applications [8] due its various properties in image processing. We can apply this method for edge enhancement & extraction, edge obstruction & pencil sketching, clip art compression artifacts removal, layer based contrast manipulation. Another popular application is edge adjustment, detail magnification, tone mapping etc.

When the Lo norm gradient minimization is used in smoothing term, it can remove low amplitude structures while globally preserves and enhance salient edge even though the boundaries are of very narrow object.

In challenging circumstances, sometimes over sharpening is unavoidable to remove details. Lo norm algorithm [8] may suffer from several halos near some edges. The edges are adjusted by solving the optimization problem it is very time consuming. Lo norm gradient minimization method gives better results than Weighted Least Square.

III. OBSERVATIONS:

Histogram Equalization	Over enhancement, Not suitable for every images, Many algorithm with some restrictions.
Adaptive histogram equalization	Automatic, reducible & locally adaptive, Preserves brightness.
Bilateral Filtering	Noniterative,local,simple, Produces gradient reversal artifacts near some edges.
Weighted least squares (WLS)	Robust, versatile, Reduces ringing, Deblurring images in presence of noise.
Lo gradient minimization	Globally locates important edges, Preserves edges better than WLS, Over sharpening.

IV. CONCLUSION

It is concluded that various image enhancement techniques are available to improve the visual appearance of an image or to convert the image to a form which is more suited for human or machine for specific application.

In image enhancement image while removing the noise. Existing image enhancement methods produces some drawbacks like gradient reversal artifacts, over sharpening, ringing blurring etc. so, there is need to introduce new technique which will reduce such drawbacks and perform smoothing as well as over sharpening to give better visual result

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