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Contrast Enhancement of HDR images using Linear Transformation and Kernel Padding

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***Abstract*— Here in this paper an efficient technique for the contrast enhancement is implemented along with the reduction of noisy pixels in the HDR images. HDR images are special images that contains high intensity pixels on which various techniques such as contrast enhancement, brightness enhancement, filtering, segmentation is very difficult, but the technique implemented here not only improves the contrast of the image but also reduces the noisy level of the pixels. The result analysis shows the performance of the proposed technique. The comparison is done o the basis of certain parameters such as PSNR, time computation, error rate and smoothness factor.**

***Keywords*—** HDR, LDR, histogram equalization, linear transformation, decomposition, Padding.

I. INTRODUCTION

Various techniques of Image processing can be used in various applications such as entertainment, healthcare, surveillance, and security. It can be used for a variety of applications such as cephalic radiography in imaging of medical [1], identification of humans [2], security of indoor surveillance [3], and crowd monitoring in outdoor environments [4]. Such application paradigms encompass a wide domain of the types of features contained in the captured images.

Contrast enhancement for gray-level images, implemented in the form of histogram transformations [5] is considered one of the fundamental processes that facilitate subsequent higher level operations such as detection and identification. The enhancement of Color images can be separating by the method of image into the chromaticity and intensity components [6]. The Image contrast enhancement [7] by a histogram modification ,implemented the form of modify the image through some pixel mapping like that the histogram of the processed image is more spread than that of the original image. Several methods have been proposed for contrast enhancement to improve the contrast enhancement of images can be classified into two main categories which one is direct method define a contrast measurement and improve the contrast. Second method is indirect method define a contrast exploiting region to improve the contrast of images.

Here in this paper various sections are being discussed, in the section II all the literature survey regarding various techniques of contrast enhancement using HDR images is discussed. In section III the proposed work methodology, which consists of histogram equalization, hdr images linear transformation and kernel padding are discussed. Results Analysis and comparisons between the existing and proposed work using HDR images are discussed in section IV. At the last Section V concludes the paper.

II. LITERATURE SURVEY

Ji Won Lee et al. [8] proposes a noise reduction method and an adaptive distinguish enhancement for local tone mapping (TM). The proposed local TM algorithm compresses the luminance of high dynamic range (HDR) image and decomposes the compressed luminance of HDR image into multi-scale sub bands using the discrete wavelet transform. In case of noise reduction, the stale images are filtered using a soft-thresholding and bilateral filter then, the active ranges of the clean sub bands are enhanced by considering local contrast using the modified luminance compression function. At the color tone-mapped image is reproduced using an adaptive saturation control parameter and generate the tone-mapped image using the projected local TM. Computer imitation by noisy HDR images shows the effectiveness of the proposed local TM algorithm in terms of visual quality as well as the local distinguishes. It can be used in various displays with noise reduction and contrast enhancement. The images that can be tone-mapped with the proposed local TM algorithm give better image quality than those of the conventional TM algorithms. That is, the proposed local TM algorithm effectively reduces coarse-grain noise and enhances the local contrast.

Yen-Ching Chang and Chun-Ming Chang [9] have proposed a new framework for the contrast enhancement using histogram equalization .Here in this technique two support and boundary values are taken and the values of the image are set according to these value. The proposed technique successfully reduces the washout appearance and reduces artifacts of the image.

Chen Hee Ooi and Nor Ashidi Mat Isa [10] proposed the new way of enhancing the contrast of the images using quadrant dynamic histogram equalizations. The proposed QDHE is the most robust method to extract the details of the low contrast images. Observing from the simulation results obtained, the QDHE has produced the best performance for both qualitative and quantitative evaluations.

Haiyan Zhao [11] offers the thought regarding article combines with human visual feature to check digital watermarking technique to insert watermarking, extracts watermarking in line with the harm state of affairs of watermarking, and that combines with other visual redundancy feature to attain an image scrambling algorithmic program that's simple to recover and a recovery theme for broken scrambling image. Abstract-HVS theory plays necessary role within the application of digital image watermarking method. Once insert watermarking, the visual masking feature of HVS can be totally wont to style digital watermarking algorithmic program with smart perceived performance. Once extracting watermarking from the broken image, human's visual feature can be combined to recover the broken image thus on acquire higher result. This rule might be applied in digital image watermarking rule to strengthen the hardiness of watermarking rule.

Wen-Chieh Lin and Zhi-Cheng Yan [12] proposed a local tone mapping method that compliments both attention and adaptation effects. We accept the High Dynamic Range (HDR) saliency chart to calculate an attention chart, which predicts the attentive regions and non attentative regions in an HDR image. The attention chart is then used to locally regulate the contrast of the HDR image according to attention and adaptation models found in psychophysics. These practical their tone mapping approach to HDR images and videos and compared with the results generated by three state-of-the-art tone mapping algorithms. This experiments show that their approach produces results with better image quality in terms of preserving particulars and chromaticity of visual saliency.

Chulwoo Lee [13] has proposed an efficient algorithm for the contrast enhancement. A novel contrast enhancement algorithm based on the layered difference representation of histograms is proposed in these techniques.

Ji Won Lee, Rae-Hong Park, and Soon Keun Chang [14] proposed a local TM algorithm, in which the HDR image segmented using K-means algorithm and a show gamma parameter is put automatically for each segmented area and it compute the luminance of an input that is the radiance map generated from a set of LDR images with changeable exposure settings and this image is divided into several regions using a K-means algorithm. Then, the tone of HDR is reproduced by a linear TM method with adaptive gamma value. It is used for contrast and color enhancement in different display and acquisition devices.

V. Mugudeeswaran and and C. G. Ravichandran [15] proposed fuzzy logic based histogram equalization for the contrast improvement. The FHE have two stages. Initially, fuzzy histogram is computed based on fuzzy set theory to hold the inexactness of gray level values in a better way compared to typical crisp histograms. Another stage, the fuzzy histogram is divided into two sub histograms based on the median value of the original image and then equalizes them independently to preserve image brightness. The qualitative and quantitative analysis of proposed FHE algorithm are evaluated using two well-known parameters like average information contents (AIC) and natural image quality evaluator (NIQE) index for various images.

Tarun Dewangan, M.A. Siddiqui, RCET Bhiali [16] proposed dynamic histogram equalization based contrast enhancement. The proposed method is based on dynamic histogram equalization and for handling gray-level and color images the same as well. As far as HE methods for gray-level images are worried, current methods tend to change the mean brightness of the image to the middle level of the gray-level range.

Iwanami, T., T. Goto, S. Hirano, and M. Sakurai [17] have proposed regional based dynamic histogram equalization for the contrast enhancement. Here in this paper DRSHE method to the block of the image in order to improve the regional image contrast with automatic parameter setting and in short computational time.

Akhilesh Verma, Archana [18] provides analysis of different contrast enhancement techniques. GA performs efficient search in global spaces to get a best solution. The algorithm does not require any prior knowledge about image in Order to select the appropriate enhancement function.

Amina Saleem**,** Azeddine Beghdadi and Boualem Boashash [19] have given a fusion-based contrast enhancement technique which integrates information to overcome the limitations of different contrast enhancement algorithms. In this method balances the requirement of local and global contrast Enhancements and a faithful representation of the original image exterior, a goal that is difficult to achieve using traditional enhancement methods.

Turgay Celik and Tardi Tjahjadi [20] propose an adaptive image equalization algorithm which automatically enhances the contrast in an input image. This algorithm use Gaussian mixture model (GMM) to model the image grey-level allocation, and the juncture points of the Gaussian components in the model are used to partition the dynamic range of the image into input grey-level intervals.

III. Proposed Methodology

The proposed method works in the following five steps:

1. Take an input HDR image.
2. Adjust contrast and brightness as well the transformation i.e. linear transformation or non-linear transformation.
3. Apply kernel padding.
4. Transformation of image using Histogram equalization.
5. Enhance the region using histogram equalization to enhance the level of contrast or brightness.

Here the input parameters from user such as contrast, brightness and the transformation (linear or non-linear) are used for the enhancement of the level of brightness and contrast and transformation is used for the scaling or filtering of the image such as scaling.

The Histograms of the original image are created to check the region where the enhancement or filtering is needed. First of all the log mean intensity pixels of the image is calculated so that the average pixel intensity of the image is determined using,

LogMeanY = exp (mean (mean (log(Y+delta))));

Now depends on the transformation technique we need to apply such as linear or non-linear the image is enhanced. In linear transformation a slope of linear value is selected and all the pixels whose intensity value is close to this slope is considered otherwise the pixels whose intensity is less or greater than this linear slope needs to be adjusted. The proposed work consists of histogram equalizations, HDR images, linear transformation and kernel padding. They are described in the following.

A. Histogram Equalization

Histogram equalization [9]-[16]-[24] is a method in image processing of contrast adjustment using the image's histogram. It is usually increases the global contrast of many images, especially when the utilizable data of the image is represented by close contrast values. Through the adjustment of the intensities can be better distributed on the histogram. This is allows for areas of lower local contrast to increase a higher contrast. Histogram equalization accomplishes by successfully spreading out the most frequent intensity values.

The technique of histogram equalization is [23] used to improve the pixel intensities of the images for the enhancement of contrast. Let f be a given image represented as a mr by mc matrix of integer pixel intensities ranging from 0 to L − 1. L is the number of possible intensity values, frequently 256. Let p denote the normalized histogram of f with a bin for expected intensity. So

$$P_n = \frac{\text{No. of pixel with intensities } n}{\text{Total number of pixels}} \qquad n = 0, 1, 2, 3\ldots\ldots$$

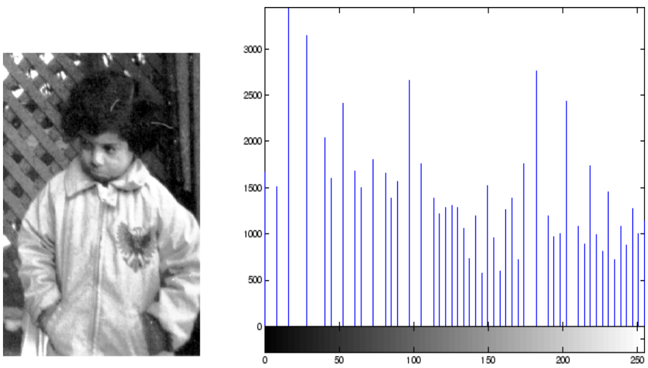

Fig.1. Histogram of the image

B. HDR Images

These are the special high dynamic range images having high intensity of the pixels in comparison with low dynamic range images. HDR image, called radiance map, is generated by the integration of various LDR images that are captured with varying exposure setting such as using auto exposure bracketing in a digital camera [21]. HDR images are sometimes captured using an HDR camera, that may contains high and low sensitivity sensors per pixel to increase DR. Noise of the HDR images, which are captured with high international organization for standardization (ISO) setting under the low light condition such as dim interior and night scene [22]. Also the dark region of HDR image has a low signal to noise ratio (SNR). Most conventional TM algorithms do not consider noise. HDR image contains both coarse grain (low-frequency) and fine grain (high frequency) noise. The larger number of LDR images that can be used may contain some noise and should be reduced. In this paper, HDR image is assumed to be generated by combining three LDR images with –1, 0, and 1 exposure value (EV) using auto exposure bracketing in a digital camera.

C. Linear Transformation

A linear transformation [24] is a special type of function that maps one vector space to another. With that said, let’s present the formal definition.

Let V and W be vector spaces. Let L be a function that maps the vector space V into the vector space W; i.e.: V, W. L is a liner transformation if and only if

- L (u + v) = L (u) + L (v) for all u and v in V, and
- L (αu) = αL (u) for all u in V and all scalars α.

This transformation completed using linear transformation between two vector space V and W is a map T: V→W such that the following hold:

1. T (V_1+V_2) =T (V_1) +T (V_2) for any vectors $V_1$and V_2 in V, and
2. T (αv) =αT (v) for any scalar α.

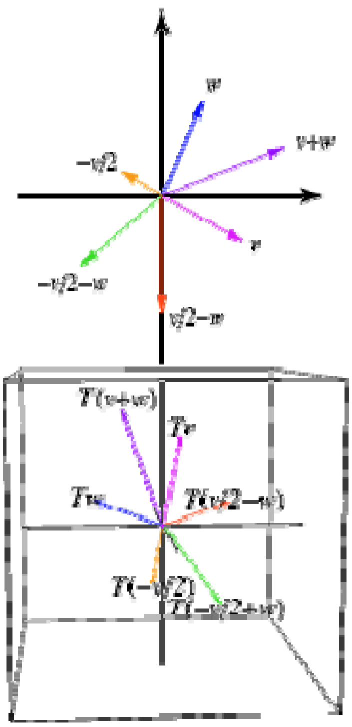

Fig.2. linear transformation

A linear transformation may or may not be injective or subjective. When V and W have the equal dimension, it is feasible for T to be invertible, meaning there exists a T^{-1} such that TT^{-1}=I. It is always the case that T (0) =0. Also, a linear transformation always maps lines to lines (or to zero).

D. Kernel Padding

The size of the blur kernel [25] is selected. The size of the kernel determines the amount of distort. Next, the variances of the Gaussian function are selected. A bigger variances will result in more distort, and a lesser variances will result less distort, as the color from each point is spread out over a smaller region. Third, the mean of the Gaussian is chosen. The mean should just be in the centred of the kernel image. Next, the values of the distort kernel matrix are filled using the mesh grid function and the equation for a two-dimensional Gaussian with mean m and variance s^2. Finally, the blur kernel is plotted the same way as the image.

IV. Result Analysis

PSNR: PSNR is the most widely used image quality metrics. The ratio (in decibels) is frequently used as a quality measurement between the original and a compressed image. It is defined the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. The higher the PSNR better quality of the compressed image or reconstructed image. The PSNR is calculated using the following equation –

$$\mathbf{PSNR=10*log_{10}(MAX^2/MSE)}$$

Where, MAX is the maximum possible pixel values of the image.

MSE: MSE is the error metrics used to compare image compression quality. The MSE represent the cumulative square error between the compressed image and the original image. Lower the value of MSE, lower the errors. The MSE is calculated using the following equation –

$$\mathbf{MSE=\Sigma_{M,N}[l_1(m,n)-l_2(m,n)]^2/M*N}$$

SMOOTHNESS: It is defined as the ration of means intensity level of the HDR image and the standard deviation of the image.

$$\mathbf{Ms= Mean (I) / Std (I)}$$

Fig.4. HDR image 2

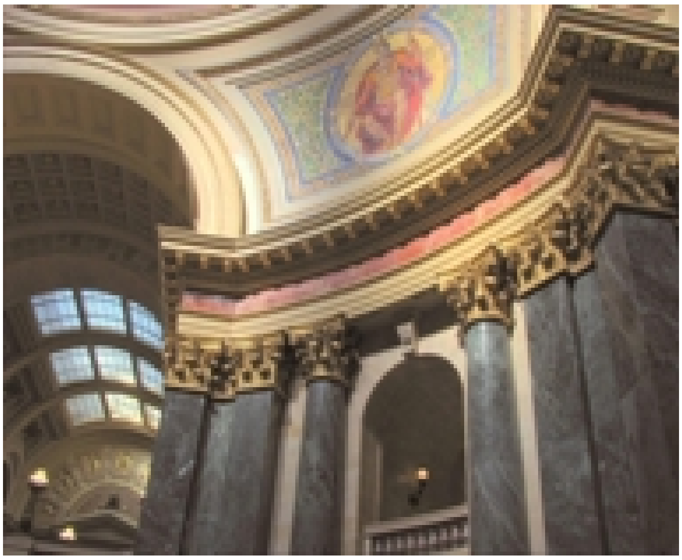

Fig.5. HDR image 3

Fig.3. HDR image 1.

Fig.6. HDR image 4

The table **a** shown below is the result analysis of the technique implemented for the HDR using bilateral filtering. Various parameters are analyzed for the J.W.Lee et al. technique.

	Time (sec)	MSE	PSNR	Smoothness
HDR image1	8.5645	3.66E+03	10.7578	11.3628
HDR image 2	1.404	3.73E+03	10.7578	11.3628
HDR image 3	4.7112	1.08E+03	10.7578	11.3628
HDR image 4	6.9888	1.24E+03	10.7578	11.3628

Table **a**. Result Analysis of the J.W.Lee et al. Work

The table **b** shown below is the result analysis of the technique implemented for the HDR using kernel padding and histogram equalization. Various parameters are analyzed for the proposed technique such as Time, MSE, PSNR and smoothness.

	Time (sec)	MSE	PSNR	Smoothness
HDR image1	3.276	0.0224	18.9786	15.6472
HDR image 2	1.3645	0.0209	14.8435	19.7553
HDR image 3	2.2308	0.0197	11.1749	15.3686
HDR image 4	2.6208	0.0507	14.2838	16.933

Table **b.** Result Analysis of the Proposed Work

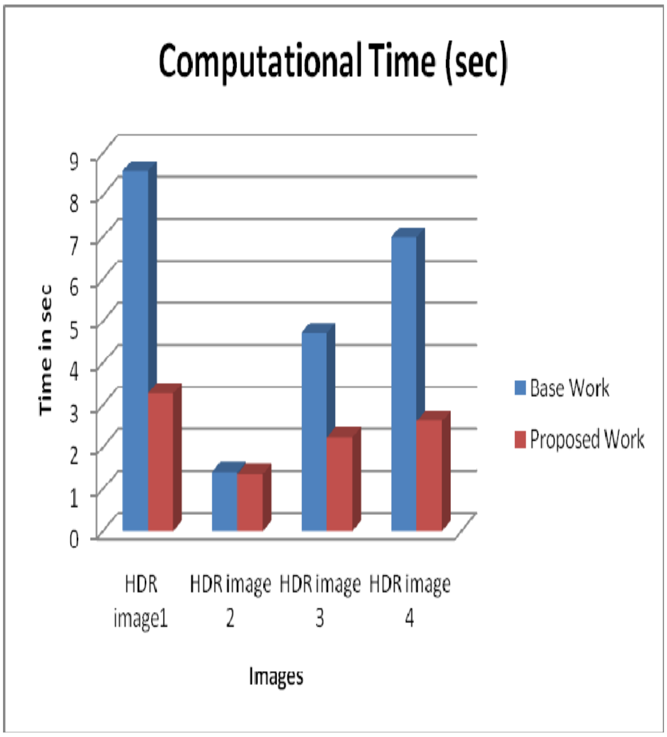

Fig.7. Comparision of Computation Time

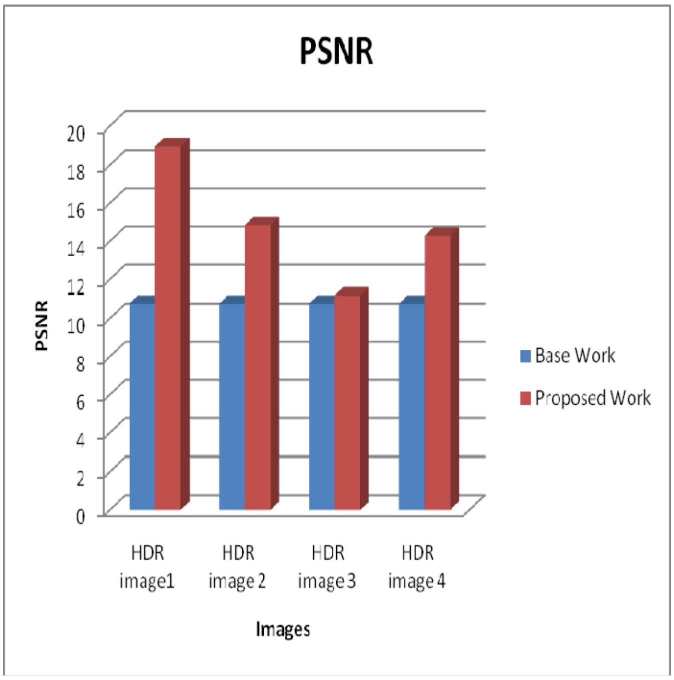

Fig.8. Comparison of PSNR

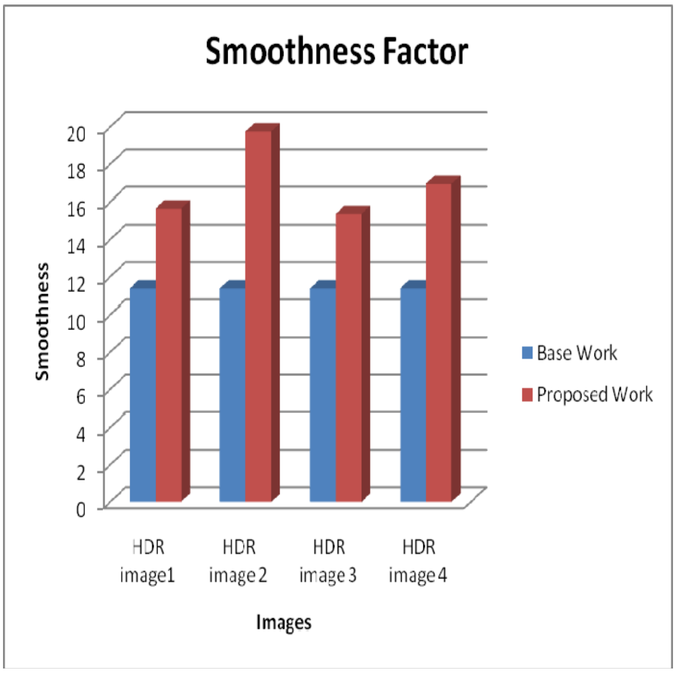

Fig.9. Comparison of Smoothness Factor

V. CONCLUSION

The proposed technique implemented here is efficient in terms of smoothness and time. Various HDR images are tested on the existing technique using Local Tone mapping and the proposed technique using hybrid combinatorial method of kernel padding and linear transformation and histogram equalization and the result analysis shows the performance of the proposed technique. The proposed technique is efficient in terms of error rate, PSNR, computational time and the smoothness factor.

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