

Contrast Enhancement of HDR images using genetic Algorithm with efficient Fitness Value

Ram Ratan Ahirwal¹, Rameshwar Nath Pathak² and Dr. Y.K Jain³

¹ Department of Computer Science, Samrat Ashok Technical Institute
Vidisha, M.P, India

² Department of Computer Science, Samrat Ashok Technical Institute
Vidisha, M.P, India

³ Department of Computer Science, Samrat Ashok Technical Institute
Vidisha, M.P, India

Abstract

Contrast Enhancement is a technique of improving the quality of image so that the brightness of the image is preserved. Although there are various techniques implemented for the contrast enhancement but contrast enhancement of HDR images is difficult to achieve. Contrast enhancement always plays fundamental role in digital image or video processing. For image contrast enhancement Histogram Equalization (HE) is one of the most commonly used methods but un-natural looking images may be produced by them and the images obtained by these methods are not desirable in applications such as consumer electronic products where brightness preservation is necessary to avoid annoying artifacts. To overcome such problems contrast enhancement of HDR images using genetic algorithm is proposed. The algorithm implemented here uses genetic algorithm for the filtering of image such as noise reduction and enhance the contrast of image. The proposed algorithm performs better as compared to the other HDR contrast enhancement techniques. The idea is to use genetic algorithm which performs a number of iterations and detect the regions in the image where enhancement is required.

Keywords: LDR, TM algorithm, Edge preservation, mutation, crossover, HDR, fitness value.

1. Introduction

Contrast enhancement is a process that is applied on images or videos to increase their dynamic range. There are several reasons for an image/video to have poor contrast: the poor quality of the used imaging device, short of expertise of the operator, and the unfavorable exterior conditions at the time of gaining. These belongings result in improper utilization of the offered dynamic range. Accordingly, these types of images and videos may not reveal all the details in the clicked scene, and may have a washed-out and abnormal look. Contrast enhancement is targeting to remove these problems, in this manner to achieve a more visually-pleasing or enlightening image or both. Characteristic viewers express the improved images as if a curtain of fog has been removed from the picture. Since now, many algorithms have been proposed for such an aim. Histogram Equalization (HE) is one of the most commonly used method for contrast enhancement. Contrast enhancement method is used to make an image clearly recognized for a specific application. A contrast stretch improves the brightness differences uniformly across the dynamic range of the image, while tonal improvements enhance the brightness differences in the shadow (dark), mid-tone

(grays), or highlight (bright) regions at the expense of the brightness differences in the other regions. Tone mapping (TM) maps high dynamic range (HDR) image to low dynamic range (LDR) image for display devices with limited dynamic range (DR). Recently TM algorithms have been developed for reproducing the tone mapped color image, in which color, contrast, and detail components are enhanced using luminance compression and color reproduction by considering the human visual system or the local statistical attribute [16]. TM algorithms are categorized into global and local algorithms in view of luminance compression [10].

Some of the image enhancement methods are; Mean preserving Bi-Histogram Equalization (BBHE) [16], equal area Dualistic Sub-Image Histogram Equalization (DSIHE) [18], Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE) [13], and Recursive Mean-Spread Histogram Equalization (RMSHE) [13] are HE based methods which tend to preserve the image brightness with a significant contrast enhancement. The benefit of contrast enhancement is to improve picture quality for better visibility and understanding. It is a bulky and time consuming process.

A noise reduction methodology associated an adaptive distinction improvement for native TM. When initial compression of the luminousness of HDR image, the planned local TM algorithmic program decomposes associate initial compressed luminance into multi-scale sub bands exploitation the distinct wavelet remodel. The rotten sub bands are filtered using a bilateral filter and soft-thresholding (LH, HL, and HH sub bands). And then, the native distinction is enhanced by associate reconciling weight that springs from the luminance compression perform with the color constraint. Finally, the color of the tone-mapped image is reproduced using associate reconciling saturation management parameter. Computer simulation with noisy HDR pictures shows the effectiveness of the planned native Tm algorithmic program in terms of the visual quality as well because the native distinction and detail preservation [7].

High-dynamic-range imaging (known as HDR) is a set of methods used in imaging and photography to capture a greater dynamic range between the lightest and darkest areas of an image than current standard digital imaging methods or photographic methods. HDR image, called radiance map, is generated by merging LDR images that are captured with untrustworthy exposure setting using auto exposure bracketing in a digital camera. From time to time HDR image is clicked using an HDR camera that has high and low sensitivity sensors per pixel to increase HDR. Noise is restrains in HDR images that are captured with high international organization for standardization (ISO) setting under the low light condition such as dim interior and night scene [3]. 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. Fine grain noise is easy to decrease, while coarse-grain noise is comparatively hard to smooth because it is difficult to distinguish between signal and noise.

Genetic algorithms are one of the best ways to solve a problem for which little is known. Genetic algorithms use the principles of selection and evolution to produce several solutions to a given problem. Based on efficiency of genetic algorithm it can be applicable for search the best output of a digital circuit. Genetic algorithm is used as a search algorithm, which is an efficient and cost effective. It has various applications. Genetic Algorithms are a unit of computational models enthused by progress. The algorithm encode a potential solution to a definite problem on a simple chromosome-like data structure and apply recombination operators to these structures as to protect significant information. Genetic algorithms are frequently viewed as function optimizer, although the ranges of problem to which genetic algorithms have been applied are quite wide.

Genetic algorithm is a probabilistic search algorithm based on the mechanics of natural selection and accepted genetics. Genetic algorithm is happening with a set of solutions [10].

(1) **Initialization:** The first process decides initial genotype, namely value and genetic length. Fig.1. shows the basic steps taken by the genetic algorithm.

(2) **Evaluation:** The second process calculates the fitness for each individual with the objective function. The valuation based on each problem.

(3) **Termination Judgment:** If the process satisfies the termination condition, the operation finishes and output the individual with the best fitness as the optimized solution.

(4) **Selection:** To generate the offspring, this process selects parents from persons. For example, if it assumes that parents the first generation, children become the second generation. The children generate the next children again. The children inherited the characteristic of the parents are generated in this way.

(5) **Crossover:** This process crosses individuals chosen by selection operation and generates the individuals of the next generation.

(6) **Mutation:** This process mutates the chromosome of new generation. The mutation is effective to escape from a local optimum solution.

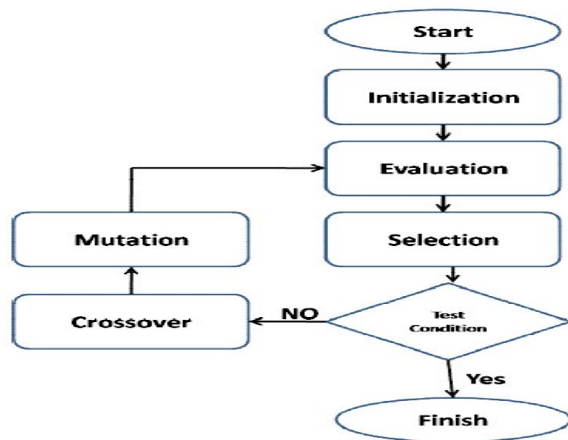


Figure 1: Flow Diagram of GA

Edge-preserving image smoothing has recently emerged as a valuable tool for a variety of applications in computer graphics and image processing. In exacting, in computational picture making it is often used to decompose an image into a piecewise smooth base layer and a detail layer. In computational photography, images are often decomposed into a piecewise smooth base layer and one or more detail layers. The base layer captures the larger scale variations in intensity, and is typically computed by applying an edge-preserving smoothing operator to the image (sometimes applied to the logarithm of the luminance or to the lightness channel of the CIELAB color space). The detail layer is then defined as the difference (or the quotient) between the original image and the base layer. Each of the resultant layers may be manipulated separately in various ways, depending on the application, and possibly recombined to yield the final result [20].

The ideal edge-preserving filter must neither blur nor sharpen the edges that separate coarse scale image features, while smoothing the regions between such edges. Unfortunately, such an operator does not exist, because in general it is impossible to unambiguously determine which edges should be preserved. Furthermore, in order to produce multi-scale base-detail decompositions, the operator must allow increasingly larger image features to migrate from the base layer to the detail layer [13]. In other words, it must allow increasingly larger regions to become increasingly smoother.

An adaptive image equalization algorithmic rule that automatically enhances the distinction input image by using Gaussian mixture modeling. The algorithm uses the Gaussian mixture to model the image gray-level distribution, and the common points of the Gaussian elements in the model are accustomed partition the dynamic vary of the image into input gray-level intervals. The vary equal image is generated by remodeling the pixels' grey levels in every input interval to the suitable output gray-level interval in line with the dominant remodeling element and also the accumulative distribution function of the input interval. to require account of the hypothesis that uniform regions within the image represent uniform silences (or set of Gaussian components) within the image histogram, the mathematician parts with small variances are weighted with smaller values than the Gaussian histogram with larger variances, and the gray-level distribution is additionally accustomed weight the elements within the mapping of the input interval to the output interval. Experimental results show that the planned algorithmic rule produces higher or comparable enhanced pictures than many progressive algorithms. in contrast to the other algorithms, the projected formula is free of parameter setting for a given dynamic vary of the improved image and might be applied to a good vary of image varieties.

2. Literature Review

For increase the dynamic range of images and videos contrast enhancement is applied. There are several methods for contrast enhancement Histogram equalization is very well known method for contrast enhancement [1][8]. This method achieves a uniform distributed histogram by using the cumulative density function of the input image. the mean brightness of the histogram-equalized image is the middle gray level of the input image regardless of its mean Histogram equalization suffers from first This is not a suitable property in some applications such as consumer electronic goods, where brightness preservation is compulsory to avoid annoying artifacts[18] To overcome brightness preservation problem, different methods that were based on Histogram Equalization have been

proposed. Secondly, histogram equalization performs the enhancement based on the global content of the image and in its discrete version large bins cannot be broken and redistributed to produce the desired uniform histogram. In other words, histogram equalization is powerful in highlighting the borders and edges between diverse objects, but may decrease the local details inside these objects, especially smooth and small ones.

In 2012 by Ji Won Lee et. al [6] propose 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 bilateral filter and soft-thresholding 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 tone-mapped image of the proposed local TM algorithm gives better image quality than those of the conventional TM algorithms. The major benefit of this scheme is better result in tone mapping. Image that is produced are rich in colors also. But this scheme is slightly time consuming and color saturation needs more improvement [6].

In order to take into account the perturbation in the resultant image intensity, a bi-histogram transformation approach for contrast enhancement was applied in [17] but the information content may be reduced due to the sacrifice in using the gray-levels effectively. Similar methods were also found in [13] where the histogram was divided into linear sectors. Modifications were made on histograms by considering the human visual properties [15] for improved viewing comfort and the resultant histograms were constructed from nonlinear curves [1].

In the same year of 2009, Tarik Arici et al [14] suggested histogram modification based system for image contrast improvement. This approach contains contrast enhancement that is posed as an optimization problem to minimize a cost function. Global contrast enhancement (GCE) method can be extended to local contrast enhancement (LCE) using similar approaches. HE is an effective technique to transform a narrow histogram by spreading the gray-level clusters in the histogram [11], [5], and it is adaptive since it is based on the histogram of a known image. On the other hand, HE without any adjustment can result in an excessively enhanced output image for some applications. HE produces images with mean intensity that is approximately in the middle of the dynamic range. A similar method called equal area dualistic sub-image histogram equalization (DSIHE) was proposed in which the two separate histograms were created using the median intensity instead of the mean intensity [19].

In 2009 by Ngai M. Kwok et al [8] gives proposal for contrast enhancement for gray level images. They used multi-objective Particle Swarm Optimization concept for betterment of images. The PSO is used in the optimization of two objectives in enhancing image contrast and preserving the mean intensity. In particular, the PSO structure is explored such as to accommodate this dual objective as inherent from the design of the PSO. Contrast enhancement for gray-level images, implemented in the form of

histogram transformations [11] is considered one of the fundamental processes that facilitate subsequent higher level operations such as detection and identification. Color images can be enhanced by separating the image into the chromaticity and intensity components [2]. The contrast enhancement can be performed by hardware devices or software algorithms.

By Zeev Farbman et. al introduce a new way to construct edge-preserving multi-scale image decompositions and show that current base detail decomposition techniques, based on the joint filter, are limited in their ability to extract detail at random scales. as a replacement for, sponsor the use of an alternative edge-preserving smoothing machinist, based on the weighted least squares optimization construction, which is mainly well appropriate for progressive coarsening of images and for multi-scale feature extraction. After describing this operator, then show how to use it to construct edge-preserving multi-scale decompositions, and compare it to the mutual filter, as well as to other schemes. Finally show the effectiveness of edge preserving decompositions in the context of LDR and HDR mapping of tone, enhancement detail, and other applications. Which may be viewed as increasing the local contrast of the finest scale information, as well as to change the global distinguish [20].

3. Proposed Methodology

Image contrast enhancement is a classical problem in image processing and computer vision. The principal objective of enhancement is to process an image so that the result is more suitable than the original image for a specific application. In this work, Contrast enhancement technique based on the genetic algorithm is proposed with an efficient implementation of fitness function. The main contribution of this method is using a simple chromosome structure and genetic operators to increase the visible details and contrast of low illumination images especially with high dynamic range. The proposed approach maps each gray level of input images to another one, such that the resulting image contains more contrast.

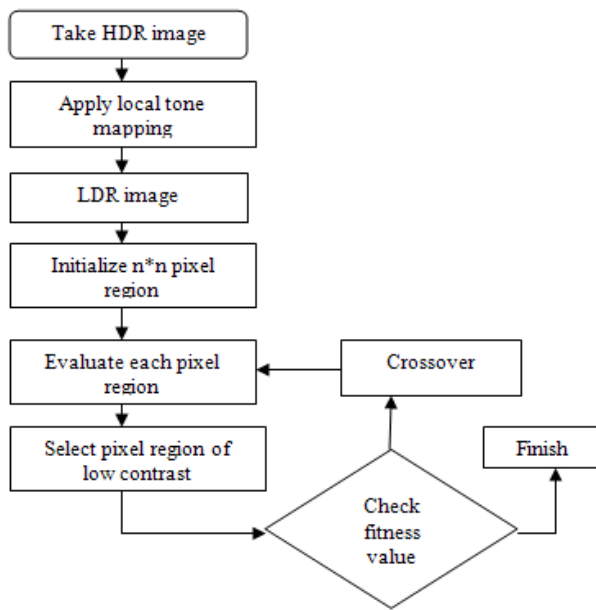


Figure 2: Diagram of proposed work

Working of proposed algorithm

- Step1.** Take a HDR image (Para A).
- Step2.** Apply local tone mapping on this HDR image to convert it into LDR.(Para B)
- Step3.** Initialize all the general parameters involved in genetic algorithm. (Para C)
- Step4.** Choose a block region of n*n in the image and calculate the fitness value from the block region.(Para D)
- Step5.** Compare the fitness value of each pixel in the block region, if the fitness value of the pixel is lower than it is rejected otherwise its contrast is better.(Para E)
- Step6.** The pixels whose contrast is less can be increased by taking the crossover of these pixels and the pixels having higher contrast value. (Para F)

Local Tone mapping

The high dynamic range images having high pixel intensities which are taken from the special devices .We first apply linear tone mapping on such HDR images. The linear tonemapper settings are based on real camera and some sort of film settings. The linear tonemapper are generally used for animations in order to avoid flickering effects in the animation. Sensitivity, f/stop, and shutter speed are all mathematically interchangeable when determining exposure. It is important to learn to think in "stops" when setting exposure inside the linear tone mapper. The initial setup of the tone mapping starts with the luminance mapping of the pixels [9].

`luminanceMap = makeLuminanceMap(hdr);`

then we will find the maximum intensity pixel of the image

`maximum = max(max(luminanceMap));`

Find the linear map of the luminance value

`luminanceMapLinear = luminanceMap / maximum;`

Finally color based tone mapping is applied over this linear map with a threshold value.

`ldrLinear = applyColor(hdr, luminanceMapLinear, 0.5);`

Hence to get linear tone mapping of the image a pixel value is selected whose intensity is medium and each of these pixels in the image is then multiplied with this pixel.

124	23	45	124
100	67	124	100
124	32	245	124
122	43	255	122

Example of linear tone mapping

$$L_i = P_i * \text{threshold value}$$

62	12	23	62
50	34	62	50
62	16	123	62
61	22	128	61

Result after linear tone mapping

Here linear tone of each and every pixel in the HDR image is multiplied by 0.5 which result in LDR image pixels.

Genetic Algorithm for contrast enhancement

Here in our proposed methodology the enhancement of contrast can be done using genetic algorithm. Since the contrast to be enhanced is of HDR images, hence it is first converted into LDR using local tone mapping algorithm as given above. Now we apply genetic algorithm for the contrast enhancement. The genetic algorithm starts with the initialization and selection of pixel regions in the image.

Initialization & Selection of Pixel regions

Here in our proposed methodology we can't apply genetic algorithm on the whole image, the idea is to select a pixel region from the image and then apply various functions of genetic algorithm. Before applying of genetic algorithm all the genetic parameters are initialized such as the number of iterations performed or maximum number of steps, fitness value etc. Here the selection of pixel region can be of 4*4 or 8*8 or 16*16. Here the selection of chromosomes value from the pixels region will be from the neighborhood of each of the pixel region and can be defined as,

$$g(x, y) = T(f(x, y), ip2, ip7, ip10, ip9)$$

Where ip2, ip7, ip10, ip9 are pixel values of image pixels 6 in the below figure.

The foremost benefit of using this technique is the effectiveness in the prediction of fitness value and time computation; also if we increase the region size by 8*8 then the performance also gets better.

Image pixel 1	Image pixel 2	Image pixel 3	Image pixel 4
Image pixel 5	Image pixel 6	Image pixel 7	Image pixel 8
Image pixel 9	Image pixel 10	Image pixel 11	Image pixel 12
Image pixel 13	Image pixel 14	Image pixel 15	Image pixel 16

Example of selection of pixel region of block size 4*4

As shown in the table above is the selection of pixel block region using transformation function. Here fitness function is calculated using the average of the pixels of these block region and on the basis of this fitness value the other pixels are calculated.

The contrast enhancement in the existing work is based on bands where the pixels are converted into low and high sub bands and the pixel values are converted according to these bands which are not efficient one resulting in higher error rate and complex.

The main problem that can be removed by using the proposed genetic algorithm is the enhancement level and scaling factor and error rate.

Objective Enhancement Criteria & Fitness Function

After the selection of genetic parameters and pixel regions the criteria for contrast enhancement is selected such as the level of contrast means low level contrast and high level contrast. Here we choose low level and high level contrast enhancement as 5. Now after the selection of enhancement criteria, fitness value of all the pixel of a particular pixel region is calculated, here we will not calculate fitness value of the all pixels, but we will calculate region wise calculation of the fitness value.

Fitness value of each pixel can be calculated by taking the sum of average of all the intensity pixels of the block region. Fitness function in genetic algorithm is used to check the fitness of the pixel means in genetic algorithm when child chromosomes can be generated then the value of child is greater than the fitness value otherwise these child chromosomes are rejected.

124	23	45
100	67	124
124	32	245
122	43	255

Example of block region of 4*4 and calculation of fitness value

$$F_i = \sum_{i=1}^n \frac{\text{intensity}(i)}{n}$$

Where, F_i is the fitness value of pixel i and is calculated as the sum of all the pixel intensities divide by the total number of pixels.

Selection & Cross Over

The selection process in genetic algorithm is based on the intensity value of pixels that are being selected using fitness values.

If child_pixels > fitness value
 Then selection is done

Else
 Rejected

Now the pixels whose values get selected a crossover of these pixels is done.

As shown in the above equation is the calculation of the fitness value for each pixel value in the image and each and every time the fitness function is calculated for each child generation. After the genetic algorithm finishes the pixel values are integrated in the row order fashion to generate the image with enhanced contrast.

Mutation

Here in the proposed algorithm we use mutate operator for the interlinking from one pixel intensity in the image to another.

The pixel value having less pixel intensity values are first removed by comparing with the fitness values and the remaining pixels are then mutate with each other to generate next level of chromosomes hence result may change from the previous one.

124	124	23	45
100	100	67	124
124	124	32	245
122	122	43	255

Example of block region of 4*4 and calculation of mutation

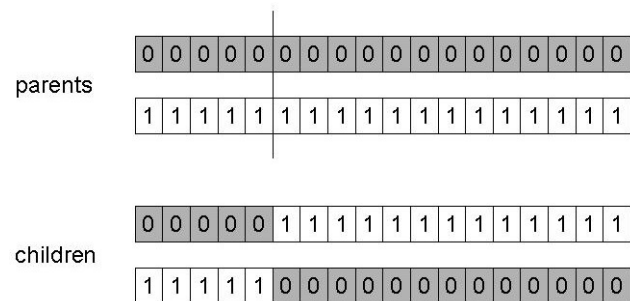
When the values are compared with the fitness values the pixel like 23,45,32 are removed depends on the fitness value, now the remaining pixels are mutate with each other so that new pixels are generated for these pixels which are removed.

Example:

1 0 1 0 0 1 0
 ↓
 1 0 1 0 1 1 0

The mutate operator can be performed using the steps as,

- Select a random point on the two parents.
- Split parents at this crossover point.
- Create children's by exchanging trails.
- P_c typically in range (0.6, 0.9).



e. p_m is called the mutation rate
 Characteristically among $1/\text{pop_size}$ and $1/\text{chromosome_length}$.

parent	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
child	0	1	0	0	1	0	1	1	0	0	0	1	0	1	1	0	0	1	1

The algorithm starts with the initialization of the genetic parameters. The HDR image to be enhanced is first applying local tone mapping feature to reduce the quality of the HDR image into LDR image. We select a pixel region of each n*n block such as 8*8 and 16*16 and 32*32 to perform the performance of the algorithm. The on the basis of the block pixel region select the region where the intensity of the pixel region is less by checking the fitness value of each pixel in the region, the pixel having less fitness value needs crossover with other high intensity pixels and mutate to get new fitness value and the process is repeated until all the pixels contains high fitness value.

4. Result Analysis

In order to test the proposed method, experiments are performed on various images regardless of the image size. The input image can be of any size. We use five HDR images to show the effectiveness of the proposed method. However, it is usually desired to have some quantitative measures in addition to subjective evaluation *i.e.* visual understanding. Therefore to assess the image enhancement and Noise reduction performance, the quantitative measures such as the NAE: The Normalized Absolute error, Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR), **NCC** (Cross-correlation), Structural Content, Avg. Difference, Max. Differences **are** used as the criterion.

To demonstrate the performance of the proposed algorithm, the presented method was implemented by Matlab on PC computer with 1.6 GHZ CPU and 1 GB RAM .some HDR images were used to show the performance of the proposed method. The applied parameter values such as the NAE: The Normalized Absolute error, Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR), **NCC** (Cross-correlation), Structural Content, Avg. Difference, Max. Differences have been shown in Table1and2 respectively for 8*8 and 16*16 blocks. The cputimes are given in table 3 and 4 for block size 8*8and 16*16 respectively. The comparison of them is shown in figure 10. Also, some other related methods have been implemented and their smoothness results were compared with proposed method in figure11.

PSNR: PSNR is the most widely used image quality metrics. This ratio (in decibels) is often used as a quality measurement between the original and a compressed image. It is defined as 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, the better the quality of the compressed or reconstructed image. PSNR is calculated using the following equation –

$$PSNR = 10 \log_{10} \left(\frac{MAX^2}{MSE} \right)$$

Where, MAX is the highest possible pixel value of the image.

MSE: MSE is the error metrics used to compare image compression excellence. The MSE symbolizes the cumulative squared error between the compressed and the actual image. The inferior value of MSE, the lower the error.

The mean-square error is calculated using the following equation –

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

NAE: The Normalized Absolute error of our proposed algorithm is better as compared to the existing algorithm.

NCC: Cross-correlation is a measure of similarity of two waveforms as a function of a time-lag applied to one of them. In image processing applications, the brightness of the image varies due to lighting and exposure conditions. In such cases, the images first can be normalized.

As shown in the below figure is the result analysis of the existing work based on different parameters. The existing work proposes the Local tone mapping of the HDR images for the contrast enhancement. The result analysis shows the performance of the contrast level. The existing technique of contrast enhancement has more error rate and contains less PSNR.

The proposed methodology implemented here using genetic algorithm is efficient one in terms of contrast enhancement level and error rate and PSNR value. The contrast enhancement using genetic algorithm performs better as compared to the existing technique.

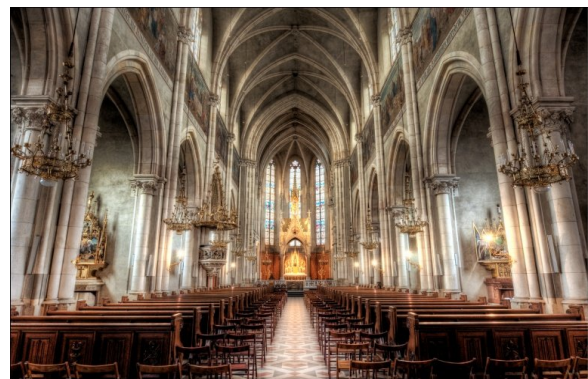


Figure 5. HDR image 1.

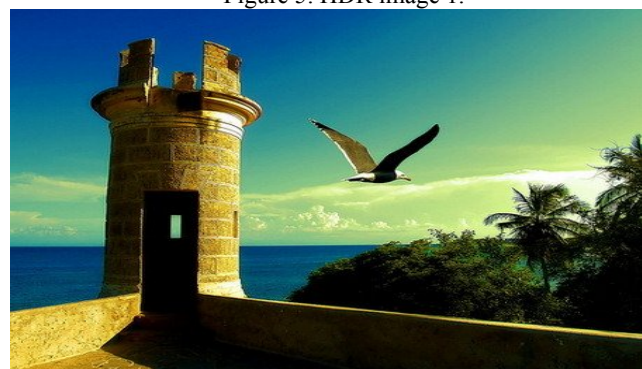


Figure 6. HDR image 2



Figure 7. HDR image 3



Figure 9. HDR image 5



Figure 8. HDR image 4

The result analysis shown below is the performance of the proposed work for 8* 8 block region. Here genetic algorithm is applied for the improvement of contrast level.

Image	MSE	PSNR	NCC	NAE	Structural Content	Avg. Difference	Max. Difference
hdr1.jpg	3.48E+03	12.7105	1.405	0.5164	0.491	58.1026	4
hdr2.jpg	2.69E+03	13.8335	1.5559	0.6429	0.4055	51.5162	27
hdr-3.jpg	2.66E+03	13.8777	1.3601	0.5249	0.5216	48.8119	0
hdr-4.jpg	2.698E+03	12.7231	1.5239	0.5923	0.4721	53.7823	14
hdr-5.jpg	2.54E+03	12.9723	1.4892	0.6124	0.5723	52.2331	18

Table 1: Analysis of Proposed Techniques on different parameters on different Images for 8*8 block size

The result analysis shown below is the performance of the proposed work for 16* 16 block region. Here genetic algorithm is applied for the improvement of contrast level. The block region of 16 *16 is used for applying the genetic algorithm on the image. Here the fitness value is calculated according to the block region, hence we take a block region of 8* 8 and then 16*16 and it can be calculated that the block region of 16*16 performs better as compared to the block region of 8*8.

Image	MSE	PSNR	NCC	NAE	Structural Content	Avg. Difference	Max. Difference
hdr1.jpg	2.75E+03	13.7407	1.5619	0.651	0.4022	52.1642	29
hdr2.jpg	3.58E+03	12.5968	1.4115	0.524	0.4864	58.9509	4
hdr-3.jpg	2.75E+03	13.7452	1.3606	0.5366	0.5197	49.9044	0
hdr-4.jpg	2.86E+03	13.8124	1.6723	0.4782	0.4892	50.5623	13
hdr-5.jpg	2.67E+03	12.5623	1.4723	0.5324	0.5238	51.4545	17

Table 2: Analysis of Proposed Techniques on different parameters on different Images for 16*16 block size

Image	CPU Time
hdr1.jpg	4
hdr2.jpg	4.2031
hdr-3.jpg	4.9375
hdr-4.jpg	4.7812
hdr-5.jpg	3.9612

Table 3: Analysis of CPU time of proposed technique for different images for 8*8 block size

Image	CPU Time
hdr1.jpg	3.7344
hdr2.jpg	3.9375
hdr-49.jpg	4.5938
hdr-4.jpg	4.1239
Hdr-5.jpg	3.7812

Table 4: Analysis of cpu time of proposed technique for different images for 16*16 block size

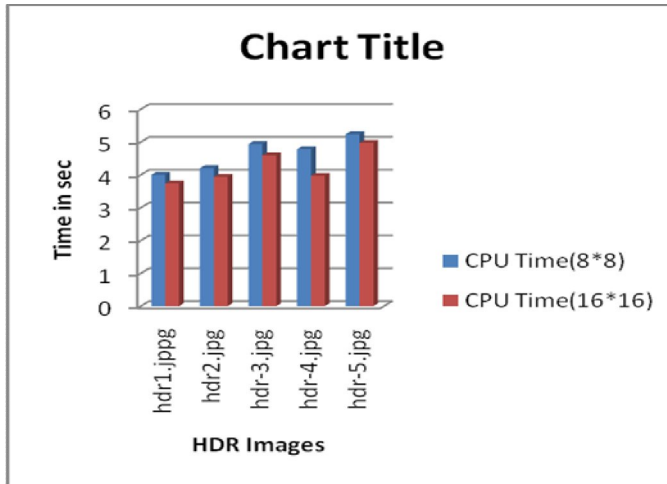


Figure 10: Comparison of CPU Time

Computational time is an important factor for the analysis of the improvement of the algorithm. Here in this paper the computational time of the proposed algorithm when applying genetic algorithm is tested. Here the time computation is calculated by first taking a block region of 8*8 and then a block region of 16*16.

As shown in the figure 10. Is the comparison of time on different block region and clear that the as the genetic algorithm is applied on the bigger block regions the time complexity reduced.

Here we use a smoothness measure to compare the signal level and the noise level in the tone-mapped images. The smoothness measure M_s is defined as,

$$M_s = \frac{\text{Mean}(I)}{\text{Std}(I)}$$

Where Mean (·) and Std (·) represent mean and standard deviation of the luminance I of the smooth region.

As shown in the below figure is the comparison of different local tone mapping algorithms for the contrast enhancement. Although there are various techniques implemented for the contrast enhancement using local tone mapping, but the contrast enhancement using genetic algorithm performs better and has high smoothness factor as compared to the existing techniques.

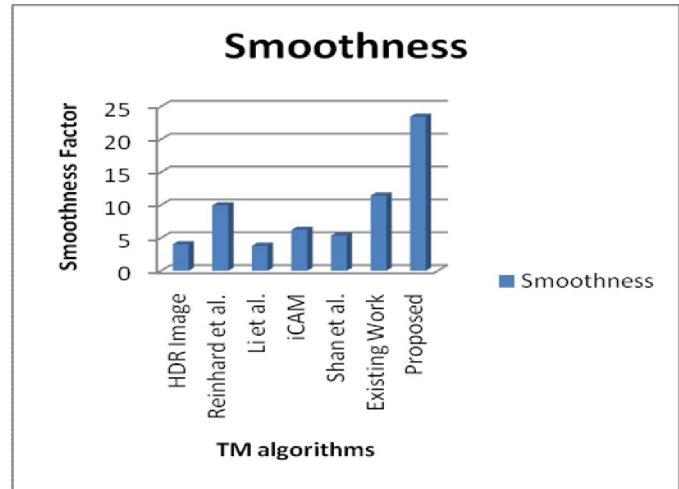


Figure 11: Performance Comparison of Smoothness of TM Algorithms

6. Conclusion

In this paper we discussed about genetic algorithm based methods that measures the fitness of an individual by evaluating the intensity of spatial edges included in the image for image contrast enhancement. Automatic image enhancement using genetic algorithm method enhanced image automatically without human interaction. Comprehensive approach to image contrast enhancement does not require any prior knowledge of image to select the enhancement function.

The proposed technique implemented here for the contrast enhancement is efficient one since it uses the concept of genetic algorithm for the enhancement of contrast of the image. The genetic algorithm used here provides better results as compared to the existing techniques of contrast enhancement. Genetic algorithm starts with the initial grid in the image and according to the number of iterations and child created its region can be enhanced. In comparison to linear transformation and histogram equalization, genetic algorithm indulges the image globally and produces image with natural contrast.

Several experimental analyses have been performed for the enhancement of contrast for HDR images. The HDR images contains high resolution graphics which is difficult to enhance, Hence various contrast enhancement techniques over HDR images fails to perform better results, Hence an efficient technique implemented here using genetic algorithm is applied to improve the enhancement of such HDR images using tone mapping. The experimental results shows the better performance of the proposed work means the proposed algorithm has high smoothness factor as compared to the other existing technique and also has high PSNR and low computational time.

Although the genetic algorithm applied for the enhancement of contrast using local tone mapping performs better results but the computational time is more and we can improve the level of enhancement and smoothness factor. Hence in the future more efficient algorithm is applied for the contrast enhancement for local tone mapping of the images such as optimization of genetic algorithm using particle swarm optimization technique.

REFERENCES

- [1] A. Raji, A. Thaibaoui, E. Petit, P. Bunel, and G. Mimoun, "A graylevel transformation-based method for image enhancement," *Pattern Recognit. Lett.*, vol. 19, pp. 1207–1212, 1998.
- [2] B. Tang, G. Sapiro, and V. Caselles, "Color image enhancement via chromaticity diffusion," *IEEE Trans. Image Processing*, vol. 10, no. 5, pp. 701–707, May 2001.
- [3] C. Liu, R. Szeliski, S. B. Kang, C. L. Zitnick, and W. T. Freeman, "Automatic estimation and removal of noise from a single image," *IEEE Trans. Pattern Analysis and Machine Intelligence*, vol. 30, no. 2, pp. 299–314, Feb. 2008.
- [4] Gonzales R. and Recharad E Woods "Digital Image Processing", Pearson Prentice Hall, ISBN: 978-81-317-2695-2, 2009.
- [5] J. S. Lim, *Two-Dimensional Signal and Image Processing*. EnglewoodCliffs, NJ: Prentice Hall, 1990.
- [6] Ji Won Lee, Rae-Hong Park, SoonKeun Chang, "Noise Reduction and Adaptive Contrast Enhancement for Local Tone Mapping" *IEEE Transactions on Consumer Electronics*, Vol. 58, No. 2, May 2012.
- [7] J. W. Lee, R.-H. Park, and S. Chang, "Local tone mapping using K-means algorithm and automatic gamma setting," *IEEE Trans. Consumer Electronics*, vol. 57, no. 1, pp. 209–217, Feb. 2011.
- [8] Ngai M. Kwok, Q. P. Ha, Dikai Liu, and Gu Fang "Contrast Enhancement and Intensity Preservation for Gray-Level Images Using Multi objective Particle Swarm Optimization", *IEEE Transactions on Automation Science and Engineering*, Vol. 6, No. 1, pp. 145- 155, January 2009.
- [9] Paul E. Debevec Jitendra Mali, "Recovering High Dynamic Range Radiance Maps from Photographs", 1996.
- [10] Q. Shan, J. Jia, and M. S. Brown, "Globally optimized linear windowed tone mapping," *IEEE Trans. Visualization and Computer Graphics*, vol. 16, no. 4, pp. 663–675, July/Aug. 2010.
- [11] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 2nd edition, Englewood Cliffs, NJ: Prentice-Hall, 2002.
- [12] Saitoh F. "Image Contrast Enhancement Using Genetic Algorithm", *Proceedings of IEEE SMC'99*, Tokyo, Japan, pp. 899-904, 1999.
- [13] S. D. Chen and A. R. Ramli, "Contrast enhancement using recursive mean-separate histogram equalization for scalable brightness preservation," *IEEE Trans. Consum. Electron.*, vol. 49, no. 4, pp. 1301–1309, Nov. 2003.
- [14] Tarik Arici, Salih Dikbas, and Yu cel Altunbasak, "A Histogram Modification Framework and Its Application for Image Contrast Enhancement", *IEEE Transactions on Image Processing*, Vol. 18, No. 9, pp. 1921 – 1935, September 2009.
- [15] T. L. Ji, M. K. Sundareshan, and H. Roehrig, "Adaptive image contrast enhancement based on human visual properties," *IEEE Trans. Med. Imag.*, vol. 13, no. 4, pp. 573–586, Dec. 1994.
- [16] Y.T. Kim "Contrast enhancement using brightness preserving bi-histogram equalization", *IEEE Trans. Consum. Electron.*, vol. 43, issue 1, pp. 1–8, 1997.
- [17] Y. T. Kim, "Contrast enhancement using brightness preserving bi-histogram equalization," *IEEE Trans. Consum. Electron.*, vol. 43, no. 1, pp. 1–8, Feb. 1997.
- [18] Y. Wan, Q. Chen, B.M. Zhang "Image enhancement based on equal area dualistic sub image histogram equalization method", *IEEE Transaction on Consumer Electronics*, vol. 45, issue 1, pp. 68–75, 1999.
- [19] Y.Wang, Q. Chen, and B. Zhang, "Image enhancement based on equal area dualistic sub-image histogram equalization method," *IEEE Trans. Consum. Electron.*, vol. 45, no. 1, pp. 68–75, Feb. 1999.
- [20] Zeev Farbman, Raanan Fattal, Dani Lischinski, Richard Szeliski, "Edge-Preserving Decompositions for Multi-Scale Tone and Detail Manipulation" The Hebrew University, 2008.
- [21] Zimmerman J. B., Pizer S. M., Staab E. V., Perry J. R., McCartney W. and Brenton B. C. "An Evaluation of the Effectiveness of Adaptive Histogram Equalization for Contrast Enhancement", *IEEE Transactions of Medical Imaging*, vol 7, issue 4, pp. 304-312, 1988.

Mr. Ram Ratan Ahirwal has received his B.E.(First) degree in Computer Science & Engineering from GEC Bhopal, University RGPV Bhopal in 2002. During 2003, August he joined Samrat Ashok Technological Institute Vidisha (M. P.) as a lecturer in computer Science & engg. Dept. and complete his M.Tech Degree (with hons.) as sponsored candidate in CSE from SATI (Engg. College), Vidisha University RGPV Bhopal, (M.P) India in 2009. Currently he is working as assistant professor in CSE dept., SATI Vidisha. He has more than 12 publications in various referred international journal and in international conferences to his credit. His areas of interests are data mining, image processing, computer network, network security and natural language processing.

Rameshwar Nath Pathak received the B.E.(First) degree in Computer Science & Engineering from Sagar institute of research and technology Bhopal , Madhya Pradesh, India, in 2011. He is currently pursuing the Master degree in Computer Science & Engineering from Samarat Ashok Technological Institute Bhopal, Madhya Pradesh, India. His research interests HDR image enhancement.

Dr.Y.K.Jain, Head CSE Deptt, SATI (Degree) Engg. College Vidisha, (M.P.), India. He has more than 30-40 publications in various referred international journal and in international conferences to his credit. His areas of interests are image processing, computer network.