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**CONTRAST ENHANCEMENT-BASED FORENSICS IN DIGITAL IMAGES**

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**ABSTRACT**

As a retouching manipulation, contrast enhancement is typically used to adjust the global brightness and contrast of digital images. In this paper, we propose two novel algorithms to detect the contrast enhancement involved manipulations in digital images. The consistency between regional artifacts is checked for discovering the image forgeries and locating the composition boundary 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. 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:** Digital forensics, contrast enhancement, LDR, TM algorithm, Edge preservation, mutation, crossover, HDR, fitness value

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**INTRODUCTION**

Images unlike text represent an effective and natural communication media for humans due to their immediacy and the easy way to understand the image content. Historically and traditionally, there has been confidence in the integrity of visual data, such that a picture printed in a newspaper is commonly accepted as a certification of the truthfulness of the news or video surveillance recordings are proposed as probatory material in front of a court of law. With the rapid diffusion of inexpensive and easy to use devices that enable the acquisition of visual data, almost everybody has today the possibility of recording, storing, and sharing a large amount of digital images. At the same time, the large availability of image editing software tools make extremely simple to alter the content of the images, or to create new ones, so that the possibility of tampering and counterfeiting visual content is no more restricted to experts. Finally, current software allows creating photorealistic computer graphics that viewers can find indistinguishable from photographic images or also generate hybrid generated visual content. In summary, today a visual digital object might go during its lifetime, from its acquisition to its fruition, through several processing stages, aimed at enhancing the quality, creating new content by mixing pre existing material or even tampering with the content. As a consequence of all previous facts, doctored images are appearing with a growing frequency in different application fields, and thus today's digital technology has begun to erode the trust on visual content, so that apparently "seeing is no longer believing". All these issues will get worse as processing tools become more and more sophisticated. This situation highlights the need for methods that allow the reconstruction of the history of a digital image in order to verify its truthfulness and assess its quality Forensic Image Processing (FIP) involves the computer restoration and enhancement of surveillance imagery. The goal of FIP is to maximize information extraction from surveillance imagery, especially imagery that is noisy, incomplete, or over/under exposed. The low imaginary quality can be caused by poor lighting, poor media quality, excessive motion of the subject, a camera in need of calibration, and noise introduced by the imaging/recording system. With digital filtering, image restoration, de-noising, and enhancement techniques, information can often be extracted from low quality imaginary.

**EXISTING SYSTEM****a) Contrast Enhancement**

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. This method achieves a uniform distributed histogram by using the cumulative density function of the input image. This is not a suitable property in some applications such as consumer electronic goods, where brightness preservation is compulsory to avoid annoying artifacts. To overcome brightness preservation problem, different methods that were based on Histogram Equalization have been implemented.

**b) 3.2 Peak/Gap Artifacts Incurred by JPEG Compression**

The prior methods fail to detect contrast enhancement in the previously middle/low quality JPEG-compressed images. To investigate the reasons behind such ineffectiveness, the impact of JPEG compression on histograms is analyzed. Once applying DCT, only DC coefficient is large while the others are small in flat blocks. After quantization, it is reasonable to assume that there exist the blocks in which merely the quantized DC coefficient is non-zero. After inverse DCT, the decompressed flat block denoted by  $I_b$  can be computed as

$$I_b(i,j) = \text{round}(\frac{nd}{8} + 128) \text{-----} (1)$$

Here,  $i, j = 0, 1, 2, \dots, 7$  are local pixel coordinates,  $q = \text{DC quantization step}$ ,  $nd = L, L + 1, L + 2, \dots, U$  denotes the quantized DC coefficient,  $L = \text{round}(-128 \times 8/q)$ ,  $U = \text{round}(127 \times 8/q)$  are deduced from the definitions in JPEG compression standard.

**c) Peak/Gap Artifacts Incurred by Contrast Enhancement**

To investigate the impact of contrast enhancement on histograms, the histogram of an enhanced image,  $h_y$  is written as

$$h_y(y) = \sum h_y(x) L(m(x)) \text{-----} (2)$$

As a result, impulsive peaks will occur in  $h_y$  at  $y$  values to which multiple  $x$  values were mapped, such as  $y = 254$ . Similarly, gaps will appear in  $h_y$  at  $y$  between the peak/ gap artifacts from contrast enhancement and those from JPEG compression.

**PROPOSED SYSTEM****a) Contrast Enhancement based genetic algorithm**

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.

**b) Genetic Algorithm**

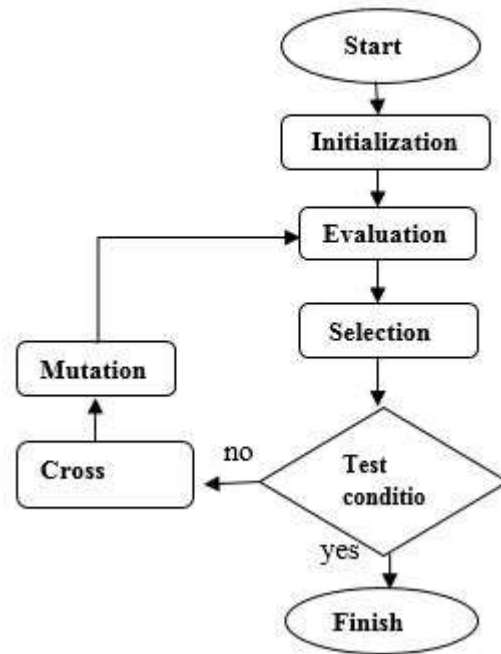
Genetic algorithms use the principles of selection and evolution to produce several solutions to a given problem. Based on efficiency of genetic algorithm it can be applicable for search the best output of a digital circuit. Genetic Algorithms are a unit of computational models enthused by progress. 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.

**c) Image Smoothing**

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. The base layer captures the larger scale variations in intensity, and is typically computed by applying an edge-preserving smoothing operator to the image. The detail layer is then defined as the difference between the original image and the base layer.

**d) Process Involved In Genetic Algorithm**

Genetic algorithm is a probabilistic search algorithm based on the mechanics of natural selection and accepted genetics.



*Fig 1 flow chart for genetic algorithm*

- i. **Initialization:** The first process decides initial genotype, namely value and genetic length.
- ii. **Evaluation:** The second process calculates the fitness for each individual with the objective function. The valuation based on each problem.
- iii. **Termination Judgment:** If the process satisfies the termination condition, the operation finishes and output the individual with the best fitness as the optimized solution.
- iv. **Selection:** To generate the offspring, this process selects parents from persons.
- v. **Crossover:** This process crosses individuals chosen by selection operation and generates the individuals of the next generation.
- vi. **Mutation:** This process mutates the chromosome of new generation. The mutation is effective to escape from a local optimum solution.

#### e) 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. The genetic algorithm starts with the initialization and selection of pixel regions in the image.

### WORKING OF PROPOSED SYSTEM

#### a) Steps Involved In Proposed System

Step1. Take a HDR image.

Step2. Apply local tone mapping on this HDR image to convert it into LDR.

Step3. Initialize all the general parameters involved in genetic Algorithm.

Step4. Choose a block region of  $n*n$  in the image and calculate the fitness value from the block region.

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.

Step6. The pixels whose contrast is less can be increased by taking the crossover of these pixels and the pixels having higher contrast value.

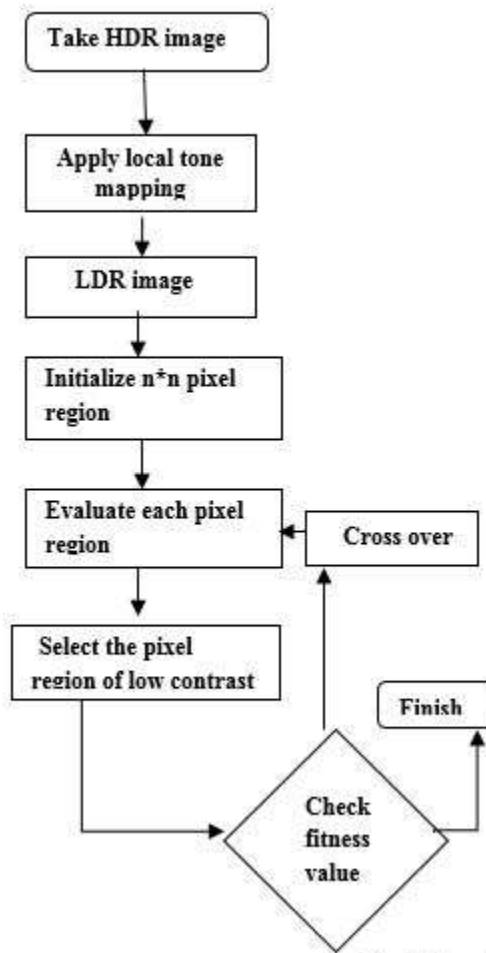


Fig 2 flow chart for proposed work

**b) 5.2 Local Tone Mapping**

The high dynamic range images having high pixel intensities which are taken from the special devices are applied in linear tone mapping on such HDR images. The linear tone mapper are generally used for animations in order to avoid flickering effects in the animation. Initial setup of the tone mapping starts with the luminance mapping of the pixels.

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

Table1 Example of Linear Tone Mapping

$$\sum I = p_i * \text{threshold value}$$

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

**Table 2 Result after liner 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.

**c) Parameters Of Genetic Algorithm**

In proposed methodology genetic algorithm cannot be applied 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,

$$g(x,y)=T(f(x,y);ip2,ip7,ip10,lp9) \text{--- (3)}$$

Where ip2, ip7, ip10, ip9 are pixel values of image pixels.

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. 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.

As shown in the table below 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 and Selection of pixel block region are shown in table 3

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

**Table 3 Selection of pixel block region**

**d) 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 and after the selection of enhancement criteria, fitness value of all the pixel of a particular pixel region is calculated, here calculate fitness value of the all pixels are not calculated, but calculate region wise calculation of the fitness value.

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

Where, Fi 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

**e) 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.

**f) Mutation**

In proposed algorithm mutate operator for the interlinking from one pixel intensity in the image to another is used. 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

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

**g) The Initialization of The Genetic Parameters**

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. 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.

**h) Contrast Enhancement**

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.



*Fig 3 Hdr image 1*

## RESULT ANALYSIS

### a) Result Analysis For 8\*8 Pixels

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. Analysis of different parameters on different Images for 8\*8 block size is shown in table 5

### b) Result Analysis For 16\*16 Pixels

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. Analysis of different parameters on different Images for 16\*16 block size is shown in table 6.

**Computational Time** Computational time is an important factor for the analysis of the improvement of the algorithm. 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. 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. comparison of cpu time 16\*16 block and 8\*8 block shown in fig 4

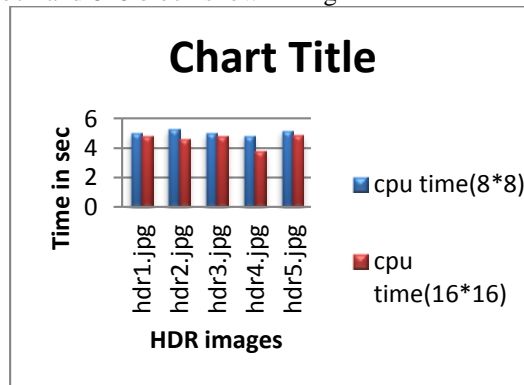


Fig 4 comparison of cpu time 16\*16 block and 8\*8 block

*Table 5 Analysis of different parameters on different Images for 8\*8 block size*

	hdr5.jpg	hdr4.jpg	hdr3.jpg	hdr2.jpg	hdr1.jpg	Image
	2.54E+03	2.698E+03	2.66E+03	2.69E+03	3.48E+03	MSE
	12.9723	12.7231	13.8777	13.8335	12.7105	PSNR
	1.4892	1.5239	1.3601	1.5559	1.405	NCC
	0.6124	0.5923	0.5249	0.6429	0.5164	NAE
	0.5723	0.4721	0.5216	0.4055	0.491	Structural Content
	52.2331	53.7823	48.8119	51.5162	58.1026	Avg. Difference
	18	14	0	27	4	Max. Difference



**Table 6 Analysis of different parameters on different Images for 16\*16 block size**

Image	MSE	PSNR	NCC	NAE	Structural	Avg.	Max.
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
hdr3.jpg	2.75E+0	13.7452	1.3606	0.5366	0.5197	49.9044	0
hdr4.jpg	2.86E+0	13.8124	1.6723	0.4782	0.4892	50.5623	13
hdr5.jpg	2.67E+0	12.5623	1.4723	0.5324	0.5238	51.4545	17

### Smoothness Measure

Smoothness measure to compare the signal level and the noise level in the tone-mapped images.

The smoothness measure  $Ms$  is defined as,

$$Ms = \frac{\text{Mean}(I)}{\text{std}(I)}$$

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

### CONCLUSION

In this project 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. 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. 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 contain high resolution graphics which is difficult to enhance. Hence various contrast enhancement techniques over HDR images fail 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 show 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.

### OUTPUT SCREEN SHOT

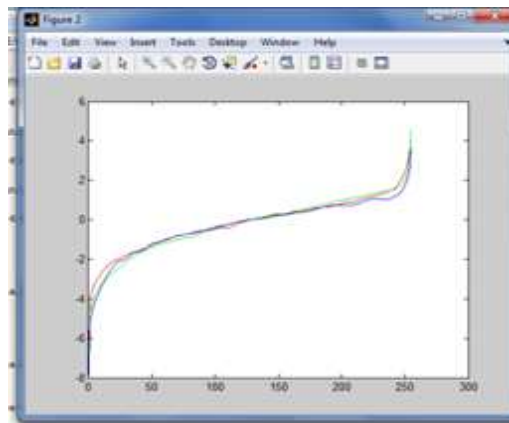
#### Input Image



#### Output Image



#### Genetic Algorithm



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