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An Improved Content Image Detail Enhancement Using Joint Trilateral Filter

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***Abstract*:** The predominant fundamental step in the image processing is Image enhancement which creates an image which is perceived by the Human Visual System (HVS) in a pleasant way. The main objective of the image enhancement technique is to increase the visual quality of an image also to bring out hidden image details or to increase the contrast of an image. The existing detail-enhancement algorithm boosts the effect of noise and also the quality of the enhanced image is not better. The proposed algorithm provides the first order fidelity for pixels at edges while other methods provides zero order fidelity for the pixels at edges in the sense the proposed algorithm is different from all the existing algorithms. The proposed algorithm also removes halo artifacts, gradient reversal artifacts and also preserves sharp edges better than existing algorithm. For the experimental results proposed algorithm, design and also execution is carried out within MATLAB R2012 b applying image handling toolbar.

Key words: Digital image processing, Detailed image, Gradient field, Edge preserving, Image smoothing, L_o norm.

1. INTRODUCTION

(i) Image Enhancement

The principle objective of the image enhancement is to process a given image so that the result is more suitable than the original image for the specific application. The simple meaning is to improve the quality of image. Enhancement doesn't change the content of original image but it changes the dynamic range of the chosen so that improvement can be easily done.

Image enhancement techniques are divided into two types namely:
1. Spatial domain methods: In this we are directly operating on pixels.
2. Frequency domain methods: In this we are operating on the Fourier Transform of an image.

(ii) Spatial Operations

The use of spatial mask for image processing operations is known as spatial filtering operations. And the mask used is called spatial filters. Basic spatial filters are low pass filter, band pass filter & high pass filter. If the centre of the mask is at location (x,y) in an image, the gray level of the pixel is (x,y) is replaced by the use of R, next we have to move the mask to next position or we can say location in the image and the process repeated for some times. This process is continued until all pixels locations have been covered.

Smoothing Filter
1. Smoothing filters are mostly used for blurring and for noise reduction from original image.
2. Before going for object recognition and all other techniques, image de blurring is an important task to perform.
3. Noise reduction is done by obtaining blurring by linear filter and also by nonlinear filtering.

(a) Median Filtering

The main objective of the median filter is to achieve noise reduction instead of blurring.

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1. This particular method is effective when the noise pattern consists of strong, spike-like components and the characteristic to be preserved is edge sharpness.
2. It is a nonlinear digital filtering technique often used to remove the noise.
3. In this filter for each input pixel f(x, y), we sort the values of the pixel and its neighbours to determine their median and assign its value to output pixel g(x,y)

(b) Bilateral Filter

1. A Bilateral filter is simply a non-linear, edge preserving and noise reducing smoothing filter
2. It is the combination of both domain filter and range filter.
3. Domain filter measures geometric closeness between the neighbouring pixels
4. Range filter measures the photometric similarity between the neighbouring pixels.

Bilateral filter is defined as

$$I^{filtered}(x) = \frac{1}{W_p} \sum_{x_i \in \Omega} I(x_i) f_r(\| I(x_i) - I(x) \|) \, g_s(\|x_i - x\|)$$

Where the normalization term

$$W_p = \sum_{x_i \in \Omega} f_r(\| I(x_i) - I(x) \|) \, g_s(\|x_i - x\|)$$

Ensures that the filter preserves energy of the image.

$I^{filtered}$ is the filtered image output;

I is the original input image which to be filtered;

X is the coordinates of the current pixel which is to be filtered;

Ω is the window that centered at X;

f_r is the range kernel for smoothing differences in the intensities;

g_a is the domain kernel for smoothing differences in the coordinates.

Merits:

1.In contrast with the filters that operate on the three bands of a colour image separately, a bilateral filter can smooth RGB colours at once and preserve edges in a way that are tuned to human perception.
2. In contrast with standard filtering, bilateral filtering produces no phantom colours along the edges in colour images and also reduces phantom colours where they appear in the original image.

Demerits:

1. It has been noticed that the bilateral filter may have the artifacts like gradient reversal artifacts in detail decomposition and HDR compression.
2. Another issue that concerning the bilateral filter is its efficiency. The brute force implementation is of O (Nr2) time which is excessively high when the kernel radius r is large.

(c) Guided Filter

We first define a general linear translation-variant filtering process, which involves a guidance image I, filtered input image P, and an output image Q. The overall filtering output at a pixel i is expressed as a weighted average:

$$q_i = \sum_i W_{ij}(I) p_j$$

Where i and j are pixel indexes; the filter kernel W_{ij} is a function of the guidance image I and it is independent of p. The guided filter is linear with respect to p.

Merits:

1. This filter has the edge-preserving smoothing property like popular bilateral filter, but it does not suffer from the gradient reversal artifacts.

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2. The guided filter has an O(N) time (in the number of pixels N) exact algorithm for both gray scale images and colour images.
3. The guided filter performs very well in terms of both quality and efficiency in a wide range of applications, such as noise reduction, detail smoothing/enhancement, HDR compression, image matting/feathering, haze removal and joint up sampling.

.**Demerits**:
1. As a locally based operator, the guided filter can't directly applicable for sparse inputs like strokes.
2. It also shares a common limitation of other explicit filter it may exhibits halos near some edges. In fact, it is ambiguous for a low level and local operator to determine which edge should be smoothed and which edge should be preserved. Unsuitably smoothing an edge will automatically result in halos near it.

(d) Gradient Filtering

An image gradient could be a directional modification within the intensity or modify a picture. Image gradients could also be accustomed extract data from pictures. In graphics software system for digital image writing, the term gradient or colour gradient is employed for a gradual mix of colour which may be thought-about as a good gradation from low to high values, as used from white to black within the pictures to the proper. Colour progression is another name suggested for gradient filtering. Mathematically, the gradient of a two-variable perform (here the image intensity function) at every image purpose could be a second vector with the elements given by the derivatives within the horizontal and vertical directions.

At every image purpose, the gradient vector points within the direction of largest potential intensity increase, and therefore the length of the gradient vector corresponds to the speed of modification therein direction. Since the intensity perform of a
Digital image is barely renowned at distinct points, derivatives of this perform cannot be outlined unless we tend to assume that there's associate underlying continuous intensity perform that has been sampled at the image points.

2. RELATED WORK

A. A new image enhancement algorithm which deals with dark regions and edges are proposed by ADIN RAMIREZ RIVERA, BYUNGYONG RYU, AND OKSAM CHAE in the year 2012 . Generally when the images are captured in abnormal lighting conditions it results in the dark images which has tiny amount of brightness. The intention of the method is to preserve flat regions information by smoothness, gradient (edge) sharpening and enhancing dark regions. The outcome of this work is to maximum enhancement by adaptively creating mapping functions producing the ad hoc transformation to every individual image. After applying the algorithm the information acquired from the boundary regions and textured regions are grouped together to get the common characteristics. Finally the basic parameter human visual system is used to boost the image in detailed way for better perception of the image in good quality.

B. A non linear transform based colour image enhancement approach is proposed by DEEPAK GHIMIRE AND JOONWHOAN LEE in the 2011 . RGB colour space is the basic colour space for colour images but RGB colour space won't accept any changes in terms of brightness and angle. In this work for processing the image to create the meaningful enhanced image RGB to HSV colour space is done. Here the enhancement process is carried on colour image and processing of the colour image is based on the HSV (hue saturation value) and in this work illuminance component V of the HSV colour space is the key component for image enhancement and remaining two components of the H and S are kept unchanged. The process of the enhancement is carried out in two peculiar steps (1) In the initial step V component is divided small overlapping blocks which helps in performing the luminance enhancement and (2) In the latter step each pixel contrast is adjusted according to the centre pixel value and its associated

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neighbourhood pixels. After successful accomplishment of two steps the enhanced V component is again combining with the H and S to form the original RGB image.

C. Multiscale retinex image enhancement scheme based on fusion approach for color restoration is proposed by SUDHARSAN PARTHASARATHY, PRAVEEN SANKARAN in the year 2012. Generally cost effective imaging systems captured images are low in quality and the display won't display the image in reliable way. Multi scale retinex algorithm has two important steps to enhance the image based on contrast parameter, in the initial step gain values of each and every pixel is taken into consideration and in the latter step the background power consumption is minimized for better visualization of the image. Displays like organic light emitting diode (OLED) uses the multi scale retinex algorithm for good quality of vision and the entire process is automatically carried on by automatic computer vision system. Image enhancement is an important step in the situation where the image is captured by cost effective imaging systems results in abnormal images. In this work author has taken primary source of enhancement as illuminance for the colour restoration in the degraded mode of images. Multiscale retinex algorithm focuses on the degraded regions of image which are the resultant of the non linear condition. Finally Multi scale retinex algorithm achieves good enhancement rate over traditional single scale retinex algorithm. [6] discussed about Improved Particle Swarm Optimization. The fuzzy filter based on particle swarm optimization is used to remove the high density image impulse noise, which occur during the transmission, data acquisition and processing. The proposed system has a fuzzy filter which has the parallel fuzzy inference mechanism, fuzzy mean process, and a fuzzy composition process. In particular, by using no-reference Q metric, the particle swarm optimization learning is sufficient to optimize the parameter necessitated by the particle swarm optimization based fuzzy filter, therefore the proposed fuzzy filter can cope with particle situation where the assumption of existence of "ground-truth" reference does not hold. The merging of the particle swarm optimization with the fuzzy filter helps to build an auto tuning mechanism for the fuzzy filter without any prior knowledge regarding the noise and the true image. Thus the reference measures are not need for removing the noise and in restoring the image. The final output image (Restored image) confirm that the fuzzy filter based on particle swarm optimization attain the excellent quality of restored images in term of peak signal-to-noise ratio, mean absolute error and mean square error even when the noise rate is above 0.5 and without having any reference measures.

3. PROBLEM FORMULATION

3.1. Problems in Existing work

In existing work, the bilateral filter, the guided image filter and content adaptive image detail enhancement algorithm cannot remove the artifacts like halo artifacts and gradient reversal artifacts. These techniques also boost noise which affects the visual appearance of the images. The concept of fog is also not introduced in the existing technique which affects the sharpness of images.

3.2. Problem Definition

The proposed algorithm uses joint trilateral filter to remove the noise and also it preserves sharp edges better than the existing methods.

4. PROPOSED ALGORITHM

Step 1: Select I_m as input image.

Step 2: Define Parameters.

λ =0.16; //Lagrangian factor;

k =4; // Detail Amplify time;

E = L_0 Enhancing (I_m, k, λ/k^2);

Step 3: Apply L_0 Enhancing.

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3.1. Evaluate

$I_X = \{(S(1), S(m) - S(end))\};$

$I_Y = \{(S(1), S(m) - S(end))\};$

3.2. The detail layer is enhanced k times in the final image. k_P is then computed.

$$K_p = 1 + \frac{K}{1+e^{\eta\cdot(v_p-\bar{v}_p)}} \quad (1)$$

3.3. Computing (h, v) when E is known. The (h, v) estimation sub problem corresponds to minimizing

$$min_{h,v}\left\{\lambda, C(h,v) + \sum_p \{\beta\left(\left(\partial_x(E_p - \hat{I}_p) - h_p\right)^2 + \left(\partial_y(E_p - \hat{I}_p) - v_p\right)^2\right)\}\right\}$$

3.4 Computing E when h and v are known: The estimation sub problem corresponds to minimizing

$$min_E\left\{(E_p - I_p)^2 + \beta\left(\left(\partial_x(E_p - \hat{I}_p) - h_p\right)^2 + \left(\partial_y(E_p - I_p) - v_p\right)^2\right)\right\}$$

4. APPLY JOINT TRILATERAL FILTER

Joint trilateral filter (JTF) is used to remove halo artifacts and also preserve the edges better than the proposed algorithm. The process of JTF is firstly done under the supervision of image G or the input image I itself. Let I_P and G_P are the intensity values at the pixel p of the nominal channel and guided input image, W_K is the kernel window centered at the pixel k, and JTF is often given by

$$JTF(I)_p = \frac{1}{\sum_{q\in w_k} W_{JTF\ (G)}} \sum_{q\in w_k} W_{JTF\ pq}(G) I_q$$

Input: filtering input image.
Output: filtering output q.

1: $\mu_I = \sum_{i=1}^{n}\sum_{j=1}^{m}\left(\frac{I_{I,J}}{N*M}\right)$

$\mu_P = \sum_{i=1}^{n}\sum_{j=1}^{m}\left(\frac{I_{I,J}}{N*M}\right)$

$corr_I = f_\mu(I.*I)$

$corr_{I_P} = f_\mu(I.*p)$

2: $var_I = corr_I - \mu_I .* \mu_I$

$cov_{I_p} = corr_{I_p} - \mu_I .* \mu_I$

3: $a = \frac{cov_{I_p}}{var_I + \varepsilon}$

$b = \mu_P - a * \mu_I$

4: $\mu_a = f_\mu(a)$

$\mu_b = f_\mu(b)$

5: $q = \mu_a .* I + \mu_b$

5. EXPERIMENTAL RESULTS

Figure 5.1 shows the input image which will be used for proposed work on which Bilateral Filter, Guided Image Filter and content adaptive image detail enhancement techniques are applied

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FIG 5.1: ORIGINAL IMAGE

Figure 5.2 shows the enhanced image that is obtained after applying existing techniques i.e. Bilateral Filter, Guided Image Filter and content adaptive image detail enhancement algorithm.

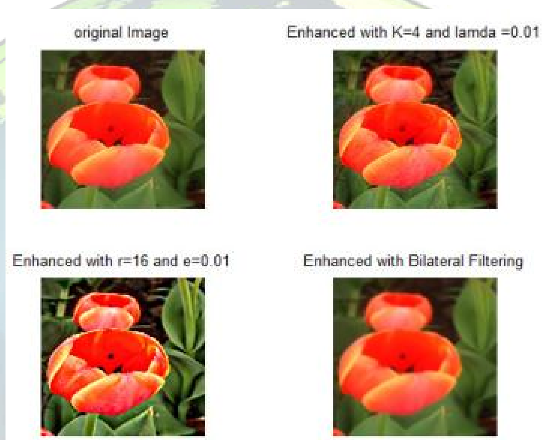

FIG 5.2:ENHANCED IMAGE

Figure 5.3 shows the output image that is obtained after applying joint trilateral filter

Enhanced with e=8 and ε= 0.1

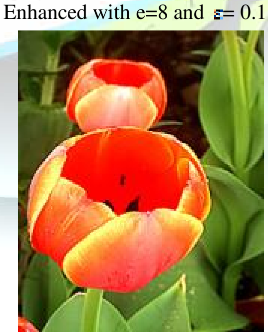

FIG 5.3: OUTPUT IMAGE (JTF)

6. PERFORMANCE EVALUATION

The experimental results are compared with the quality factors like PSNR, L2RAT, NIQE, SSIM and MSE the key purpose is always to increase the PSNR, NIQE, SSIM, L2RAT and MSE (mean square error) need to be decreased.

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Table: 1 Performance Evaluation Table (Tulips)

Quality Factor	Bilateral Filter	Guided Filter	L0 Norm Optimization	Proposed Method
PSNR	14.6508	15.8178	16.0151	16.9022
MSE	2.22	1.98	1.62	1.21
L2RAT	0.8161	0.8703	0.9004	0.9893
NIQE	5.0798	5.9914	6.0872	6.9091
SSIM	0.6351	0.6547	0.6887	0.7561

7. CONCLUSION

The comparative analysis has clearly shown that the proposed technique is better than the existing techniques. The quality of image is better than the existing technique. The effect of noise is also covered in this paper and tries to remove these effects. In near future, the technique is improved by using intelligence technique and also used appropriate filters to reduce the effect of noise.

REFERENCES

[1] Fei Kou, Weihai Chen, ZhengguLi and Changyun Wen, “Content Adaptive Image Detail Enhacement”, ieee signal processing letters, vol.22, no.2, 2015.

[2]. Kai-Han Lo, Yu-Chiang Frank Wang, Member, IEEE, and Kai-Lung Hua, Member, IEEE “Edge-Preserving Depth Map Upsampling By Joint Trilateral Filter”,2016.

[3] K. He, J. Sun and X.Thang, “Guided Image Filtering” , IEEE Trans. Pat. Anal. Mach. Intel., vol. 35, no. 6, pp. 139–140, 2013.

[4] R. C. Gonzalez and R. E. Woods, Digital Image Processing. Upper Saddle River, NJ, USA: Prentise-Hall, 3nd ed ,2002.

[5] C. Tomasi and R. Maduchi, “Bilateral filtering for gray and color images” ,in fifth Int. Conf. Computer Vision, 1998.

[6] Christo Ananth, Vivek.T, Selvakumar.S., Sakthi Kannan.S., Sankara Narayanan.D, “Impulse Noise Removal using Improved Particle Swarm Optimization”, International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 3, Issue 4, April 2014,pp 366-370

[7] Z. Farbman, R. Fattal, D. Lischinshi, and R. Szeliski, “Edge-preserving decompositions for multi-scale tone and details manipulation”, ACM Trans. Graphics, vol. 27, no. 3, 2008 , pp. 249–256.

[8] L. Xu,C. Lu, Y. Xu, and J. Jia, “Image Smoothing Via L_0 Gradient Minimization,” ACM Trans. Graphics, vol. 30, no. 6, 2011.

[9] C. T. Shen, F. J. Chang, Y. P. Hung, and S. C. Pei, “Edge-Preserving Image Decomposition Using L1 Fidelity With L0 Gradient,” SIGGRAPH Asia 2012 Tech. Briefs, p. 6, 2012.

[10] G. Deng, “A Generalized Unsharp Masking Algorithm,” IEEE Trans. Image Process., vol. 20, no. 5, pp. 1249–1261, 2011.

[11] S. Bae, S. Paris, and F. Durand, “Two-Scale Tone Management for Photographic Look,” in Proc. ACM Siggraph, 2006.

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Available online at www.ijartet.com

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[12] J. Portilla, "Image restoration through l0 analysis-based sparse optimization in tight frames," in 16th IEEE Int. Conf. in Image Processing (ICIP), 2009, 2009, pp. 3909–3912.
[13] F. Kou, Z. Li, C. Wen, and W. Chen, "L0 smoothing based detail enhancement for fusion of differently exposed images," in 8th IEEE Conf. Industrial Electronics and Applications (ICIEA 2013), 2013, pp. 1398–1403.
[14] S. C. Pei, C. T. Shen, and T. Y. Lee, "Visual enhancement using constrained l0 gradient image decomposition for low backlight displays," IEEE, Signal Process. Lett, vol.19, pp.813–816, 2014.

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