Volume 5, Issue 2, February 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Merge L_0 Gradient Minimization Technique

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Abstract-Image smoothing is one of the techniques of image enhancement that is used for enhancing the image features. An effective image smoothing method removes the noise from the image and preserves its local (fine details) as well as global features. This paper shows the comparison between L_0 gradient minimization smoothing and the new proposed method. The L_0 gradient minimization method is a very powerful smoothing method that can remove low-amplitude structures and globally preserve and enhance salient edges, but raise the problem of over-sharpening and tone-mapping. The new method merges the L_0 gradient minimization with some new functions and gives better results while smoothing. The new method also overcomes the problem of over-sharpening and tone mapping arise by the L_0 gradient minimization smoothing. This paper shows the experimental results of L_0 gradient minimization smoothing algorithm versus new smoothing method on different color images.

Keywords – PSNR, SSIM, Gradient.

I. INTRODUCTION

From the human vision point of view the quality of image is an important aspect. The quality of image is affected largely by the noise. So, in image processing software, image smoothing is an essential and important part. Image smoothing is the part of image enhancement [1]. The main aim of image smoothing is to enhance the quality of image. Image smoothing is the method that captures important patterns in the image, while leaving out the noise. Image smoothing also helps in preserving edges.

In general, smoothing filters are used to remove noise from the image. Smoothing filters are categorized into linear and non-linear smoothing filters. Linear smoothing filters, remove the noise by replacing each pixel by an average of its spatial neighbors, but it blurs edges like region boundaries. Nonlinear smoothing filters have been developed to overcome the shortcoming of linear smoothing filter [15]. Non-linear smoothing filters, remove noise as well as preserves important features during smoothing [2].

This paper presents an enhanced method for edge preserving smoothing. It has been adopted for several applications like image de-noising, feature or edge extraction, tone mapping and contrast adjustment. The new method relates to earlier edge preserving smoothing methods like [Tomasi and Manduchi 1998; Garnica et al. 2000; Ke Chen 2000; Durand and Dorsey 2002; Paris and Durand 2006; Farbman et al. 2008; Subr et al. 2009; Kass and Solomon 2010; Xu. Li et al. 2011; Shobha et al. 2012] used to remove noise as well as preserving edges.

Algorithmically, the new method is based on the L_0 gradient minimization method [3]. It is the better version of L_0 gradient minimization method [3]. The L_0 gradient minimization is very effective method used for sharpening the major edges by increasing the steepness of transition while eliminating a manageable degree of low-amplitude structures. Over-sharpening and tone mapping are the limitations of L_0 gradient minimization method. So, in this paper shows the results to give better results as comparative to previous edge-preserving smoothing methods and overcome the problem of Over-sharpening and tone mapping.

II. RELATED WORK

This section gives the review of previous methods used for edge preserving smoothing. Anisotropic diffusion [Perona and Malik 1990; Black et al. 1998] suppress the noise while preserving important structure with edge-stopping function to prevent smoothing from crossing strong edges. Bilateral filter [Tomasi and Manduchi 1998] smooths images while preserving edges with a nonlinear combination of nearby pixel values. Bilateral filter works on gray as well as color images. Its accelerated versions: [Paris and Durand 2006] accelerate the bilateral filter using down-sampling in space and intensity, [Weiss 2006] developed fast median and bilateral filter, aims for effective noise removal tool and [Chen et al. 2007] presented the real-time edge-preserving image manipulation.

[Garnica et al. 2000] presented an edge preserving smoothing method for edge extraction and image segmentation that is highly effective in removing the noise from homogeneous area and preserves image edges and corners. [Chen Ke 2000] proposed an adaptive smoothing method for noise removal and feature preservation. [Durand and Dorsey 2002] developed a new technique based on a two-scale decomposition of the image into a base layer and a detail layer for the display of high-dynamic-range images that reduces the contrast while preserving detail. [Bae et al. 2006] proposed a method for tone management. [Farbman et al. 2008] presented edge-preserving multi-scale image decompositions for tone and detail manipulation. [Subr et al. 2009] developed edge preserving smoothing method based on Local Extrema.

[Kass and Soloman 2010] proposed histogram based smoothing filter. [Xu. et al. 2011] proposed a new image editing technique for image smoothing with L_0 gradient minimization method .its aim is to preserve global edges by eliminating the low-amplitude structures. [Shobha, et al. 2012] developed an approach for smoothing an image with the use of optical flow computation. [Goyal et al. 2012] gave the comprehensive review on different image smoothing techniques.

III. PROPOSED WORK

A proposed work for image smoothing merges the L_0 gradient minimization with some new schemes to give the better results as comparative to earlier L_0 gradient minimization. This proposed work divided into following steps: Average Filter, Alpha-Blending, Un-sharp Mask Filter, Contrast Adjustment and earlier method.

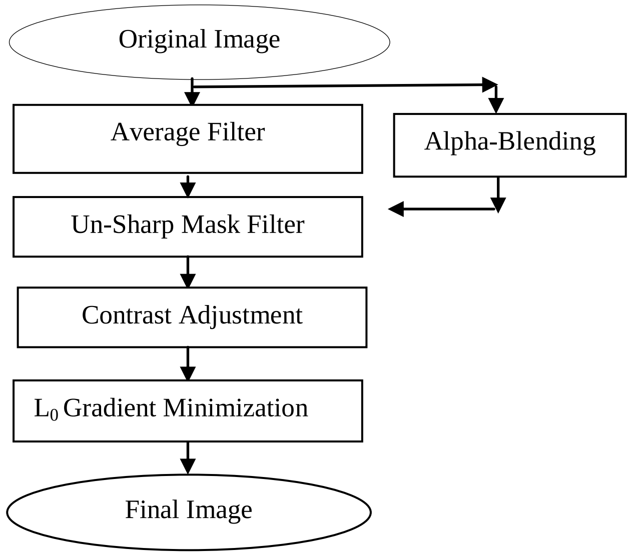


Fig 1: Flow Chart of Proposed method

Following are the steps for Proposed Work:

STEP 1: Read the color image as input mage
STEP 2: Apply the average filter on input image to remove the noise. The basic idea behind filter is for any element of image take an average across its neighborhood. After removing the noise image is passed to next step.
STEP 3: Alpha blending method is applied. It is the process of combining a translucent foreground color with a background color and thereby producing a new blended color. Alpha blending method combines the two images and passes it to next step.
STEP 4: In this Step, average filtered image and alpha blended image passes to Un-Sharp Mask Filter for enhancing the edges via procedure subtract an Un-Sharp or smoothed image from the original image.
STEP 5: Once the edges enhanced, perform the Contrast adjustment method for adjusting the color values of the image.
STEP 6: Then Merge the output image with the L_0 Gradient Minimizations method.
STEP 7: Final image is retrieved in better visual quality.

IV. PERFORMANCE METERICS

With the help of different parameters like PSNR, SSIM and Gradient, earlier and proposed L_0 gradient minimization method are compared.

Peak Signal to Noise ratio (PSNR): The MSE represents the cumulative squared error between the compressed and the original image and PSNR represents a measure of the peak error. Peak Signal to Noise Ratio should be as large as possible which means that the content of signal in the output is large and the noise is less.

$$PSNR = 10LOG\left(\frac{255^2}{MSE}\right)$$

Structural Similarity (SSIM) index is a method for measuring the similarity between two images. The SSIM metric is calculated on various windows of an image. The resultant SSIM index is a decimal value between -1 and 1, and value 1 is only reachable in the case of two identical sets of data. The measure between two windows x and y of common size N×N is:

$$SSIM(x,y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

With μ_x the average of x ; μ_y the average of y ; σ_x^2 the variance of x ; σ_y^2 the variance of y

σ_{xy} the covariance of x and y ; L the dynamic range of the pixel-values (typically this is $2^{\#bits\ per\ pixel}-1$).
$c_1=(k_1L)^2$, $c_2=(k_2L)^2$ Two variables to stabilize the division with weak denominator. $k_1=0.01$ And $k_2=0.03$ by default.

Gradient of Image returns the numerical gradient of the matrix F. FX corresponds to dF/dx, the differences in x (horizontal) direction. FY corresponds to dF/dy, the differences in y (vertical) direction. The spacing between points in each direction is assumed to be one. When F is a vector, DF = GRADIENT (F) is the 1-D gradient.

V. EXPERIMENTAL RESULTS

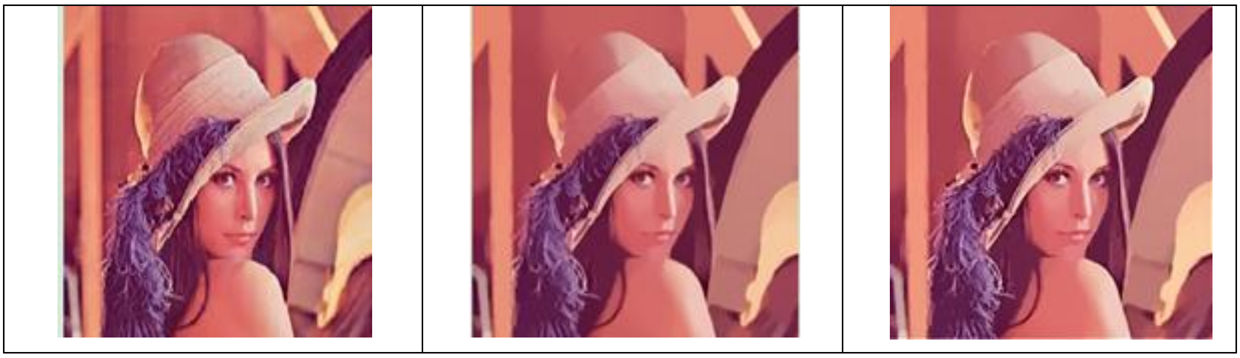
This section shows the implementation results of earlier and proposed L_0 Gradient Minimizations method on different images.

1. Experimental Result of Image 1 :

2(a) 2(b) 2(c)

Fig 2: Implementation of Image 1 (a) Original Image (b) Earlier L_0 Gradient Minimizations (c) Proposed L_0 Gradient Minimizations.

2. Experimental Result of Image 2 :



3(a) 3(b) 3(c)

Fig 3: Implementation of Image 2 (a) Original Image (b) Earlier L_0 Gradient Minimizations (c) Proposed L_0 Gradient Minimizations.

3. Experimental Result of Image 3 :

4(a) 4(b) 4(c)

Fig 4: Implementation of Image 3 (a) Original Image (b) Earlier L_0 Gradient Minimizations (c) Proposed L_0 Gradient Minimizations.

4. Experimental Result of Image 4 :

5(a) 5(b) 5(c)

Fig 5: Implementation of Image 4 (a) Original Image (b) Earlier L_0 Gradient Minimizations (c) Proposed L_0 Gradient Minimizations.

Table I: Implementation and comparison results of earlier and proposed L_0 Gradient with different Parameters on Image 1

Techniques / Parameters	PSNR	SSIM	Gradient
L_0 Gradient	49.334	0.0052813	0.040906
Proposed L_0 Gradient	52.2471	0.0054773	0.054673

TableII: Implementation and comparison results of earlier and proposed L_0 Gradient with different Parameters on Image 2

Techniques /Parameters	PSNR	SSIM	Gradient
L_0 Gradient	57.3254	0.0042183	0.028581
Proposed L_0 Gradient	60.539	0.0044078	0.050952

Table III: Implementation and comparison results of earlier and proposed L_0 Gradient with different Parameters on Image 3

Techniques / Parameters	PSNR	SSIM	Gradient
L_0 Gradient	88.2352	0.014024	0.0097808
Proposed L_0 Gradient	92.7188	0.014385	0.021015

Table IV: Implementation and comparison results of earlier and proposed L_0 Gradient with different Parameters on Image 4

Techniques / Parameters	PSNR	SSIM	Gradient
L_0 Gradient	64.3182	0.014248	0.021803
Proposed L_0 Gradient	67.3236	0.01466	0.031757

VI. CONCLUSION

This research paper enhances the previous used image smoothing algorithm. In proposed work some new functions are added to earlier L_0 gradient minimization method. In present work the L_0 gradient method with alpha blending combine the features of un-sharp masked image and preserves the global details/edges as well as local details/edges. The new method gives the better visual quality image as compared to previous one. The comparison is performed on the basis of performance measures like PSNR, SSIM and Gradient. In future, the parameter values for PSNR, SSIM and Gradient will be improved to get full resolution image.

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