Volume 4, Issue 6, June 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Review on Enhanced L_0 Gradient Technique for Image Smoothing

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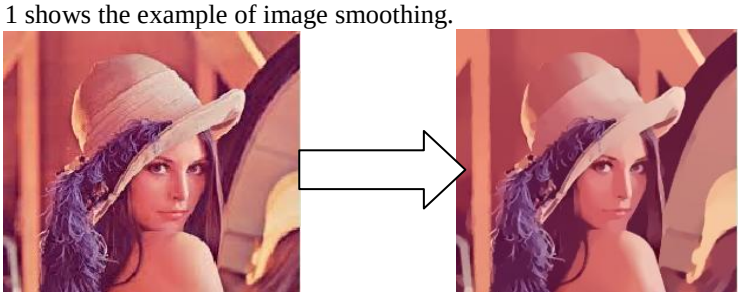
Abstract-We proposed a new and enhanced edge preserving image smoothing method. It is proposed for the effective removal of the noise from the digital image as well as preserving the important features of the image. Unlike other existing edge preserving smoothing methods, our method merges the L_0 gradient minimization smoothing method with some new functions, like average filter for noise removal, un-sharp mask filter for edge preserving, alpha blending to linearly interpolate two images and adjusting the contrast, while overcoming the limitations. The L_0 gradient method is effective for maintaining the global edges and enhances salient edges of the image but also raised problem of Over-Sharpening that removes the fine details from the image and also create the problem in tone mapping. In this paper we show that our method gives the better quality image. We also demonstrate our proposed method on a variety of applications such as edge extraction, noise removal and contrast enhancement of colored images.

Keywords – PSNR, SSIM, Gradient.

I. INTRODUCTION

Image smoothing is the key technology for image enhancement, so it is a essential and powerful module in various image-processing software. Image smoothing is the method helps in eliminating the noise from the images as well as helps in preserving edges. Different smoothing filters introduce to remove noise from the image. In general, smoothing filters are classified into two categories: linear and nonlinear. Linear smoothing filters help in removing the noise, by replacing each pixel by an average of its spatial neighbors. Different linear filters like mean and Gaussian [13].The limitation of linear filters that it blurs edge of the image like region boundaries. For this purpose, Non-linear smoothing is used to preserve important features along with noise removal during smoothing [5]. As edges play very essential role in human perception of images as well as in the analysis of images. So, it is important to smooth images without disturbing the sharpness and the position of edges [3]. So, different non-linear filters used like median, Kuwahara, bilateral, adaptive filter for edge preserving smoothing. We in this paper presents a enhanced method for edge preserving smoothing, which is related to the previous methods like Bilateral filter [Tomasi and Manduchi 1998], Fast bilateral filter for the display of high dynamic range images [Durand and Dorsey 2002], signal processing approach [Paris and Durand 2006],edge preserving decompositions [Farbman et al. 2008], multi-scale image decomposition based on local extrema [Subr et al. 2009],histogram based image smoothing [Kass and Solomon 2010], L_0 gradient minimization[Xu. Li et al. 2011]. Our method is based on the L_0 gradient minimization method [1]. This method globally control total number of non-zero gradients between pixels to enhance the prominent edges. But also have some limitations like over-sharpening and tone mapping. In some images the fine details removed completely. So, in this paper we work on enhancing the L_0 gradient method to give better results as comparative to previous edge-preserving smoothing methods. Following fig. 1 shows the example of image smoothing.



(a) (b)

Fig. 1 Image Smoothing (a) Noisy Image (b) Smoothed Image

II. RELATED WORK

In this section, we first briefly review previous works which are directly related to our work. These related works include methods like L_0 gradient minimization, Anisotropic Diffusion, Weighted Least Squares Optimization, Bilateral filter.

Xu, L., Lu, C., Xu, Y., Jia,J. [1] have proposed the technique of image smoothing with L_0 gradient minimization method .This method is based on the spatial changes in which a restriction is placed upon the total number of non-zero gradients between pixels so that to globally enhancing the prominent edges, even if the boundaries of objects are much contracted.

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They proposed this method for different purposes like image recognition, image segmentation, object classification, pencil sketch production, edge extraction, removing noise and unimportant details etc. They used the bilateral filter for removing the image noise. They also shows that this method gives the much better results as comparison to previous used techniques like TV, quantization , segmentation , local histogram mode-filtering.

B.N. Shobha, et al. [3] has developed an approach for smoothing images in optical flow computation. Optical flow is the pattern of apparent motion of objects and edges, which gives the spatial arrangement of the objects viewed and discontinuities in the optical flow helps in image segmentation. Discontinuities are in the form of noise. For the purpose of texture smoothing and edge preservation, they used comparison between different linear and non-linear smoothing filters like Gaussian filter, kuwahara filter, savitzky-Golay filter and hybrid median filter to obtain better optical flow vectors. As a result they showed that kuwahara filter performs the worst as comparative to all other filters.

A.Goyal, et al. [2] presented a comprehensive review paper on image smoothing techniques. They make analysis on some of the image smoothing methods like Gaussian Smoothing, Edge Preserved Filtering, Bilateral Filter, Optimization-Based Image Filtering, Nonlinear Diffusion Filtering, Robust Smoothing Filter, Gradient Weighting Filter, Guided Filter Kernel, Guided Image Filter. In analysis ,they shows the feature of which extent filter smooth the images and also shows the shortcomings of different smoothing filters.

Tomasi, C., and Manduchi, R. [4] introduced bilateral filter for gray and color images .Bilateral filter is non-linear and non-iterative filter that preserve the edges by mean of combining the nearby pixels values in image. They used the technique to combine the gray levels or color based on their geometric closeness and their photometric similarity in both range and domain. They shows, in comparison with the other traditional filters, that their method giving the better results in terms of edge preserving smoothing and also shows their method operates on three bands of color at once.

Perona, P., And Malik, J. [11] proposed a new scale-space and edge detection algorithm using anisotropic diffusion method. In their technique, the diffusion coefficient is used in such a way to support the intra-region smoothing as comparative to inter-region smoothing, so as to extract the global information after removing the noise from the mage. This method does not necessitate any comparison of images at different scales, as the shape and position are preserved at every single scale and preserves the edge junctions.

Subr, K., Soler, C., and Durand, F. [6] have proposed the technique of multi-scale image decomposition based on the local extrema for preserving the edges. In this method, they basically captures the image details based on the constraint the oscillations between local minima and local maxima and also shows the comparisons between existing edge-preserving image decomposition algorithms , in which details were captured based on the contrast variation. The Challenges for developing this new method is to smooth an input image by dividing the image into multiple-scale layer and efficiently take out fine scale features while preserving the softer salient edges.

III. PROPOSED ALGORITHM

The most common benefit of image smoothing is to remove the noise from the image. Different edge-preserving image smoothing methods are used for preserving the important features or structures or salient edges in the image, so as to lead the improvement in the visual quality of the image. Based upon the limitation of L_0 gradient minimization smoothing method, we enhance the version that helps in preserving the local as well as global edges in the image. In our proposed method, we merge the L_0 gradient minimization smoothing method with some methods to enhance the local as well as global edges. As shown in following Fig. 2, we first use average filter so as to remove the noise, side by side create alpha blend image of original input image and then after combining both the images, use un-sharp mask filter. The un-sharp filter is a simple sharpening operator which enhances edges. Contrast adjustment is used for the tonal enhancement. Tonal enhancements improve the brightness differences in the shadow (dark), midtone (grays), or highlight (bright) regions.

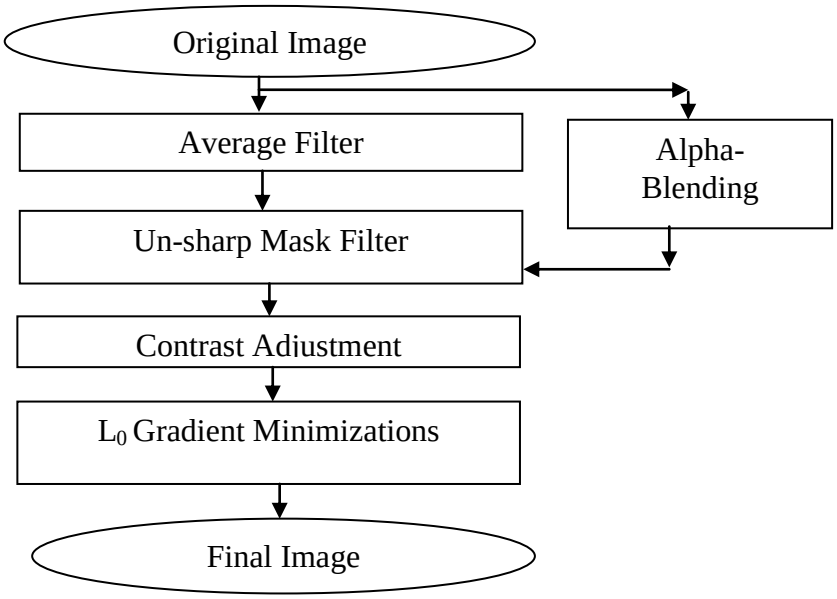

Fig. 2 Proposed Method for Image Smoothing

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IV. CONCLUSION

As in the earlier techniques, we calculate the edge preservation and contrast adjustment to be taken care. L_0 gradient with alpha blending merge the features of un-sharp masked image with 50% transparency features and it yields better visible quality in obtained image. In future we will securities the results with different quality parameters like SSIM, gradient and PSNR.

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