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A Novel Methodology for Image Processing using Hybrid Median Filter

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Abstract: Digital image processing has revolutionized the content perception from physical photo appearance to digital image appearance by implementing the digitalization. Digital image processing helps to achieve good process in various research fields but still enhancing the degraded content to normal content is concerned area. Image enhancement attains attention due to its high application applicability. A novel framework is proposed in this paper by combine the edge based weighting scheme with guided image filtering to get proposed weighted guide image filtering (WGIF). WGIF scheme yields low complexity as GIF and preserve the sharp gradient information. WGIF has ability to provide the local and global smoothing filters advantages and successful to avoid the halo artifacts. In practical WGIF is for single image feature enhancement. Further, this is enhanced to remove that type of noise in maximum amount by preserving the main image features. Image processing consists of many filters in order to remove the impulse noises. One of the filter is Hybrid median filter which is somewhat improved version of median filter, which removes the noise better than median filter. Experimental results provide low complexity and high performance over traditional state of art methods.

Keywords: Guided Image Filter, Halo Artifacts, Low Complexity, Image Enhancement, Hybrid Median Filter.

I. INTRODUCTION

Digital image is defined as "An image is not an image without any object in it". Human visual system has ability to perceive the objects in digital image using edges in efficient manner.Halo artifacts introduces blur in digital image which makes perception of content difficult. Various filtering techniques have designed in literature to preserve the global and local statistics but none of them can meet the desired requirements and various algorithms yields high complexity which fails them to achieve practical reliability. Digital image processing domain has different research fields and all these research fields have applications ranging from low level to high level. Edge preservation in all these research fields attains attention and implementation of smoothing filters has ability to filter noise content by preserving the edge information. Smoothing algorithms can be classified into two types namely global filters such as bilateral filter, tri-lateral filters, and finally guided image filter. Global filters attain images with good quality but these filters are highly expensive. Local filters are considered as alternative to global filters which are simple and cost effective but fail to conserve the sharp edges information like global filters. When local filters are forcefully adopts to smooth edges it results halo artifacts. Halo artifacts produced by bi-lateral filter and guided image filter are fixed in equipped way using similarity parameter in terms of range and spatial. Bi-lateral filtering mechanism is considered as adaptive filter and this adaptive mechanism helps to handle the halo artifacts and on negative side it destroys the 3D convolution form.

An interesting algorithm named weighted guided image filtering scheme is proposed by combining the edge-based weighting scheme along with guided image filtering. Calculation of edge based weighting scheme is calculated by using 3×3 local variance in a guidance image. This local variance scheme of one individual pixel is normalized by all pixels local variance in guidance image. The acquired normalized weights of all pixels are then adaptively adapted to WGIF. WGIF helps to avoid halo artifacts in accurate manner for excellent visual quality. The intricacy of WGIF is same as GIF. The proposed weighted guided image filtering (WGIF) is applied for multiple purposes as single image mist removal, single image detail enhancement and different exposed images fusion. Image filters produce a new image from an original by operating on the pixel values. Filters are used to suppress noise, enhance contrast, find edges, and locate features. If we want to enhance the quality of images, we can use various filtering techniques which are available in image processing. There are various filters which can remove the noise from images and preserve image details and enhance the quality of image. The common noise which contains the image is impulse noise. The impulse noise is salt and pepper noise (image having the random black and white dots). Mean filter not perfect for remove impulse noise. Impulse noise can be removed by order statistics filter. The median filter is the filter removes most of the noise in image. But there is advanced filter called hybrid median filter which preserves corners with removal of impulse noise.

II. METHODOLOGY

Digital image composed of three contents namely color, shape and texture. Assessing the image information based on edges (gradient) has ability to perform the enhancement tasks and fusion in reliable way in the field of digital image processing. Acquiring the digital content of images with good visual quality in computational photography and other applications with complexity is still concerned area because many global filters yields high complexity which show adverse impact on enhancement process.. In this paper, a strategy is implemented to enhance the image contents based on edge information by incorporating the guided image filter (GIF) with novel edge based weighting scheme to form weighted guided image filter with minimal complexity and better visual quality. The edge information plays an important role in implementing weighted guide image filtering algorithm for various applications. The key element of proposed algorithm is to ensure a confined linear model between a guidance image (G) and filtering output. The confined linear model ensures filtering output has an edge only if the respective guidance image (G) has an edge. Consider G as guidance image and the respective variance is denoted by. The edge based weighting schemes is well defined by local variance of 3×3 local variance windows of all pixels as follows:

$$\Gamma_G(P') = \frac{1}{N}\sum_{P=1}^{N}\frac{\sigma_{G,1}^2(P') + \varepsilon}{\sigma_{G,1}^2(P) + \varepsilon} \quad \textbf{(1)}$$

Where ε is a small constant and its value is selected as $(0.001\times L)^2$ while L is the dynamic range of the input image. All pixels in the guidance image are used in the computation of $\Gamma_{G,1}$(P'). In addition, the weighting $\Gamma_{G,1}$(P') measures the importance of pixel P' with respect to the whole guidance image. The value of $\Gamma_{G,1}$(P') is usually larger than 1 if P' is at an edge and smaller than 1 if P' is in a smooth area. Clearly, larger weights are assigned to pixels at edges than those pixels in flat areas by using the weight $\Gamma_{G,1}$(P'). Applying this edge-aware weighting, there might be blocking artifacts in final images. To prevent possible blocking artifacts from appearing in the final image, the value of $\Gamma_{G,1}$(P') is smoothed by a Gaussian filter and the smoothing operation is carried out at weighting mechanism.

III. PROPOSED METHODOLOGY

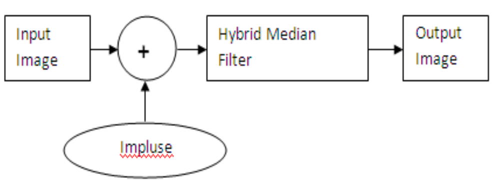


Fig.1. The Block Diagram of Image Restoration Using HMF.

The impulse removal can be very much good in hybrid median filter. So by that hybrid median filter the almost impulse noise is removed from image as shown in Fig.1. The filter which removes unwanted things. In order to remove that image noises we can use the filter such as

- **Linear Image Smoothing Filters:** One method to remove noise is by convolving the original image with a mask that represents a low-pass filter or smoothing operation. For example, the Gaussian mask comprises elements determined by a Gaussian function. This convolution brings the value of each pixel into closer harmony with the values of its neighbours. In general, a smoothing filter sets each pixel to the average value, or a weighted average, of itself and its nearby neighbours of the Gaussian filter is just one possible set of weights.
- **Nonlinear Image Smoothing Filters:** A median filter is an example of a non-linear filter and, if properly designed, is very good at preserving image detail. To run a median filter: 1. consider each pixel in the image, 2. sort the neighbouring pixels into order based upon their intensities, 3. replace the original value of the pixel with the median value from the list.

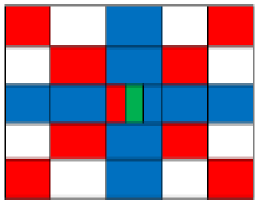
A. Median Filter

Median filtering is a non-linear filtering technique that is well known for the ability to remove impulsive-type noise, while preserving sharp edges. The median filter is a order statistics filter. Also Mean filter is used to remove the impulse noise. Mean filter replaces the mean of the pixels values but it does not preserve image details. Some details are removes with the mean filter. But in the median filter, we do not replace the pixel value with the mean of neighbouring pixel values, we replaces with the median of those values. The median is calculated by first sorting all the pixel values from the surrounding neighbourhood into numerical order and then replacing the pixel being considered with the middle pixel value.

B. Hybrid Median Filter

Hybrid median filter is windowed filter of nonlinear class that easily removes impulse noise while preserving edges. In comparison with basic version of the median filter hybrid one has better corner preserving characteristics. The basic idea behind filter is for any elements of the signal (image) apply median technique several times varying window shape and then take the median of the got median values. The hybrid median filter takes two medians: in an "X" and in a "+" centered on the pixel. The output is the median of these two medians and the original pixel value. B = hmf (A, n) performs hybrid median filtering of the matrix A using an n x n box. Hybrid median filter preserves edges better than a square kernel (neighbour pixels) median filter because it is a three-step ranking operation. Data from different spatial directions are ranked separately. Three median values are calculated: MR is the median of horizontal and vertical R pixels, and MD is the median of diagonal D pixels. The filtered value is the median of the two median values and the central pixel C: median ([MR, MD, C]). As an example, for n = 5:

$$\begin{bmatrix} D & * & R & * & D \\ * & D & R & D & * \\ R & R & DCR & R & R \\ * & D & R & D & * \\ D & * & R & * & D \end{bmatrix}$$



Y = median {MR, MD, C}

Hybrid median filter algorithm:

- Place a cross-window over element;
- Pick up elements;
- Order elements;
- Take the middle element;
- Place a +-window over element;
- Pick up elements;
- Order elements;
- Take the middle element;
- Pick up result in point 4, 8 and element itself;
- Order elements;
- Take the middle element.

The below figure illustrates the hybrid image filter calculation as:

$$\begin{pmatrix} 1 & 5 & 21 & 4 & 7 \\ 15 & 2 & 3 & 6 & 10 \\ 48 & 5 & 29 & 45 & 15 \\ 12 & 55 & 6 & 23 & 55 \\ 14 & 12 & 5 & 19 & 15 \end{pmatrix}$$

- The above 5x5 box filter centred pixel value 29 can be change to 15 by using hybrid median filtering. In this way we can smoothing the images while preserving the edges.
- The MR value is: 15(3,5,5,6,15,21,29,45,48)
- The MD value is:14(1,2,6,7,14,15,23,29,55)
- So the centred pixel value is :MEDIAN OF[MR MD C]
- i.e. Y=MEDIAN OF [14 15 29]
- Y=15

For all window filters there is some problem. That is edge treating. If you place window over an element at the edge, some part of the window will be empty. To fill the gap, signal should be extended. For hybrid median filter there is good idea to extend image symmetrically. In other words we are adding lines at the top and at the bottom of the image and add columns to the left and to the right of it. A hybrid median filter has the advantage of preserving corners and other features that are eliminated by the 3 x 3 and 5 x 5 median filters. With repeated application, the hybrid median filter does not excessively smooth image details (as do the conventional median filters), and typically provides superior visual quality in the filtered image. One advantage of the hybrid median filter is due to its adaptive nature, which allows the filter to perform better than the standard median filter on fast-moving picture information of small spatial extent.

IV. RESULT SUMMARY

In this section, the performance of the proposed technique is estimated. The below depicted figures represents the resultant for different operations like Enhancement, smoothing, and haze removal.

A. Single Image Detail Enhancement

In this section, the performance of the proposed technique is estimated. To measure the efficiency of our technique, RMSE, PSNR and RUNTIMES are calculated. We choose a two set of images to check the performance of the proposed method. In Table I, the RMSE, PSNR and RUNTIME values for WGIF and proposed technique for given input image as shown in Fig.2.

(a) (b) (c) (d) (e)

Fig.2. comparison of enhanced images by proposed and WGIF algorithms; (a, d) images to be enhanced; (b, c) enhanced images by WGIF algorithm; (c, f) enhanced images by proposed algorithm.

TABLE I: Comparision Of Metrics For Two Sets Of Images Enhanced Images By WGIF & GIF

Metric	Enhanced image by WGIF		Enhanced image by HMF	
	SET 1 Image	SET 2 Image	SET 1 image	SET 2 Image
RMSE	0.465	0.515	0.144	0.172
PSNR	51.67	53.90	64.98	63.40
TIME	1.625	0.035	0.076	0.016

B. Fusion Of Differently Exposed Images

The visual quality of the fused images by the proposed algorithm is comparable to that of the fused images by the WGIF algorithm. Therefore, the proposed algorithm can be applied to design a detail enhanced fusion images with the fast speed and at the same time, it has an excellent visual quality than the WGIF algorithm as shown in Fig.3. The running time and the quality of the proposed algorithm are respectively 1.52 seconds,0.78 while those of the WGIF algorithm are respectively 0.89 seconds, 0.1.

(a) (b) (c)

Fig.3. comparison of fusion of differently exposed images by proposed algorithm and WGIF algorithm; (a) input image; (b) fused image by WGIF algorithm; (c) fused image by proposed algorithm.

C. Single Image Haze Removal

Images of outdoor scenes could be degraded by haze, fog, and smoke in the atmosphere. The degraded images lose the contrast and color fidelity. Haze removal is thus highly desired in both computational photography and computer vision applications. The resolutions of the images in below Fig.4 are 183 × 275, and 960 × 1280 respectively. The running times of the proposed algorithm are respectively 0.95, and 2.12 seconds while those of the WGIF algorithm are respectively 0.93, and 1.05 seconds.

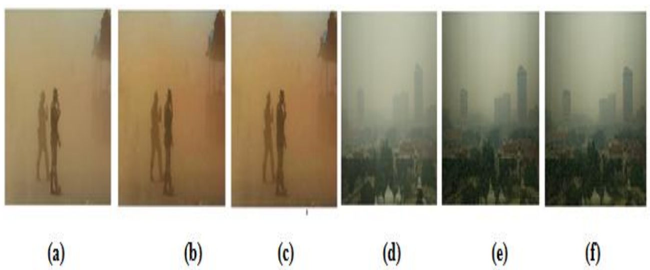


Fig.3. comparison of proposed haze removal algorithm and WGIF haze removal algorithm by using two set of images with haze; (a, d) two images with haze; (b, e) de-hazed images by the WGIF algorithm; (c, f) de-hazed images by the proposed algorithm.

V. CONCLUSION

An optimized framework is proposed in this work by incorporating the hybrid median filtering to get the efficient results. The impulse noise can be removed efficiently and smooth the all noise other than impulse noise. The hybrid median filters have some of the advantages in image processing. For repeated application the hybrid median filter does not excessively smooth image details, Edge treating is possible. Hybrid median filter preserves edges better than a median filter, Preserves brightness difference.

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