Modified Adaptive Bilateral Filter for Sharpness Enhancement and Noise Removal with High Boost Filtering

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***Abstract*—In this paper, we present the adaptive bilateral filter for sharpness enhancement and noise removal using high boost filtering (HBF). This filter sharpens an image by increasing the slope of the edges without producing overshoot or undershoots. This approach to sharpness enhancement is primarily different from the unsharp mask (USM). It is unlike the previous slope restoration algorithms since the ABF does not involve detection of edges or their orientation, or extraction of edge profiles. In the adaptive bilateral filter using high boost filtering, the edge slope is enhanced by transforming the histogram via a range filter with adaptive offset and width. This filter is able to smooth the noise, while enhancing edges and textures in the image. The parameters of this filter are optimized with a training procedure. ABF with high boost filtering restored images are significantly sharper than those restored by the adaptive bilateral filter.**

Keywords —Bilateral filter, de-blurring, noise removal, range filter, sharpness enhancement, slope restoration, High boost filter (HBF).

INTRODUCTION

Adaptive bilateral filtering using high boost filtering is favoured in image processing as for its ability to reduce noise while preserving the structural information of an image. The detail-preserving property of the filter is principally caused by the nonlinear filter part. It selects the pixels of similar intensity which are afterwards used for average operation by the linear component. The quantity of noise reduction via selective averaging and also the amount of blurring via low-pass filtering are each adjusted by two parameters. There are many applications in image processing such as Contrast Enhancement, Depth Reconstruction, Data Fusion, 3D Fairing where it is important to remove noise in the images before these subsequent processes. Thus various techniques for removing noise in images are described in this paper. Adaptive bilateral filtering algorithm is a non-linear and non-iterative image de-noising method in spatial domain which utilizes the spatial information and the intensity information between a point and its neighbours to smooth the noisy images while preserving edges well. The adaptive bilateral filter is chosen for one unique reason: It reduces noise while preserving details. The adaptive bilateral filter embodies the idea of a combination of domain and range filtering. The domain filter averages the nearby pixel values and acts thereby as a low-pass filter. The range filter stands for the nonlinear component and plays an important part in edge preserving. This component allows averaging of similar pixel values only, regardless of their position in the filter window. If the value of a pixel in the filter window diverges from the value of the pixel being filtered by a certain amount, the pixel is skipped. To address the second problem of the adaptive filter, locally adaptive sharpening and smoothing algorithms have been proposed. The histogram of the edge strength is used to classify pixels into smooth regions, soft edges, and hard edges, which are subsequently processed with different sharpening strengths.

LITERATURE SURVEY

Many researchers have worked on image de-noising techniques. The adaptive bilateral filter (ABF) for sharpness enhancement and noise removal is presented [1]. A noise reduction method and an adaptive contrast enhancement for local tone mapping (TM) are presented [2].

A parallel version of the bilateral filter using a lazy sliding window, suitable for SIMD type architectures is presented [3]. An efficient and scalable design for histogram-based bilateral filtering (BF) and joint BF (JBF) by memory reduction methods and architecture design techniques to solve the problems of high memory cost, high computational complexity, high bandwidth, and large range table is presented [4]. Mithun Das Gupta, Jing Xiao (2010) proposed a new filter called Bi-affinity filter for color images. This filter is similar in structure to the bilateral filter which does not require the explicit conversion of the RGB values to perception based spaces such as CIELAB. The bi-affinity filter measures the affinity of a pixel to a small neighbourhood around it and weighs the filter term accordingly. We show that this method can perform at par with standard bilateral filters for color images. The small edges of the image are usually enhanced leading to a very easy image enhancement filter [5]. Xing-Fang Huang; Jiang-She Zhang (2009) proposed a novel local adaptive noise reduction operator based on a location shifting procedure. Performance of the method is illustrated by simulation and real images, which show an encouraging improvement compared with other methods. [6].

Adaptive Bilateral filter (ABF) proposed by Zhang and Allebach in the year 2008 which not only smoothed the

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image but also sharpens the image by increasing the slope of the edges. The main disadvantage of this filter is that it does not sharp the edge at greater level. It just removes the noise present in an image and smoothed the image. [7]

PROPOSED METHODOLOGY

As discussed above, Adaptive Bilateral filter is a smoothening filter and it doesn't sharpen the edges of image at greater level. To overcome this limitation, an Adaptive Bilateral filter using high boost filtering is proposed which not only smoothed the image but also sharpens the image by greater extinct by increasing the slope of the edges.

ABF with high boost filtering remains same from its previous version in two ways. Firstly an offset φ is introduced to the range filter so as to shift the range filter on the histogram and this causes sharpening of edges. The other modification done is making the width of the range filter, σr adaptive. It helps in identifying which pixel values are similar and needs to be averaged. But it mainly differs with previous algorithm that is; it is often desirable to emphasize high frequency components representing the image details (by means such as sharpening) while still keeping low frequency components representing the basic form of the signal. In this case, the high-boost filter can be used to enhance high frequency component without eliminating the low frequency components:

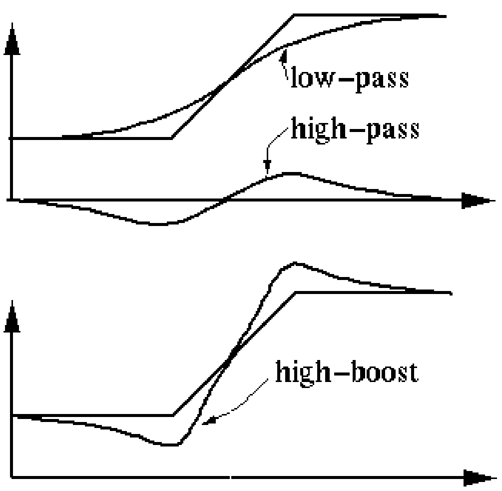
HBF image = k (original image) – LPF image

= (k-1) original image + original image – LPF

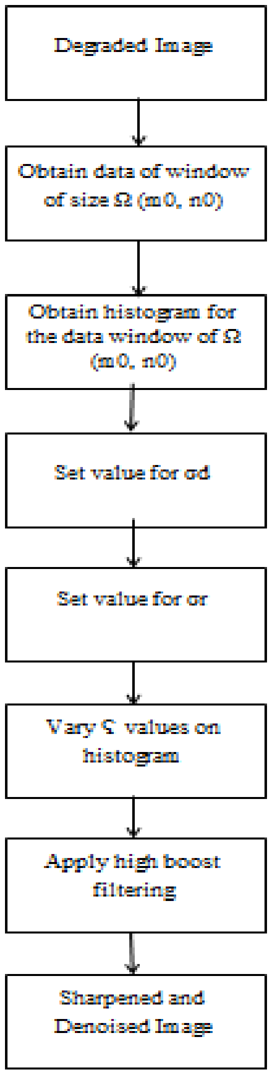
= (k-1) original image + HPF image

where k is any positive scaling factor.

For k-1, HBF image = HPF image.



FLOWCHART



ALGORITHM

STEP 1: Start.
STEP 2: Read input image.
STEP 3: Verify image exists and is valid.
STEP 4: Differentiate between grey scale and colour image.
STEP 5: Normalization of input image
STEP 6: Obtain the data of window size Ω (m0, n0) on the image
STEP 7: Obtain histogram for the data window size Ω (m0, n0) on the image
STEP 8: Set value for σd
STEP 9: Set value for σr
STEP 10: Vary ς values on histogram
STEP 11: Apply high boost filtering
STEP 12: Sharpened and Denoised image
STEP 13: End

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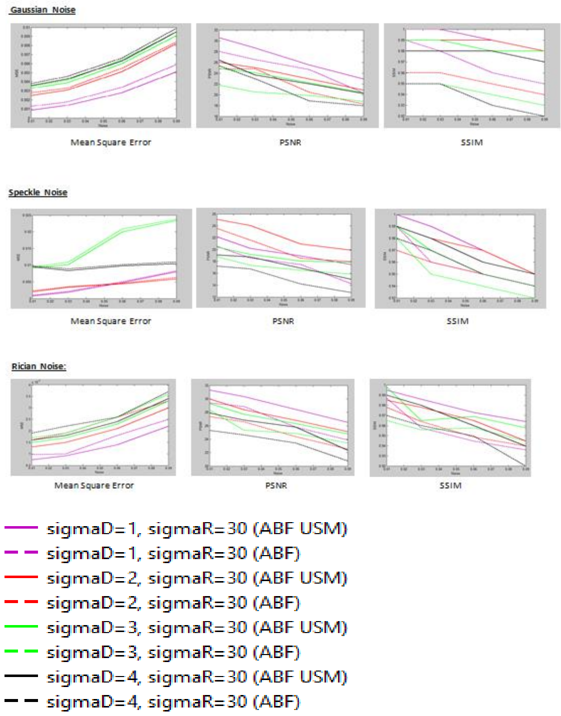
ADVANTAGES

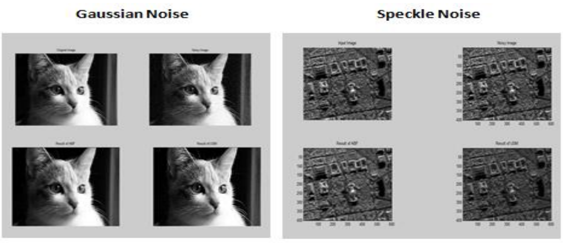
It sharpens images by increasing the slope of the edges over the conventional bilateral filter.

By combining offset and range of width filter, the technique becomes much more powerful and versatile. As a result overall quality of de-noised is improved.

High frequency components are emphasized without eliminating low frequency component hence renders sharpen image.

RESULTS AND DISCUSSION





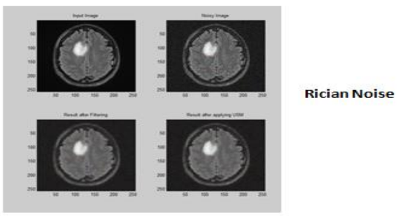


Fig1: Original Image, Fig2: Noisy Image, Fig3: Result of Adaptive bilateral filter,
Fig4: Result of Adaptive bilateral filter with high boost filtering for all the three noises

The study shows that the adaptive bilateral filter with high boost filtering (USM) has greater efficiency. The peak SNR is higher in case of adaptive bilateral filter using USM than the conventional adaptive bilateral filter. And by observing the graph of SSIM (Structural Similarity Index) we get to know that the quality of image after applying USM to ABF is better as compared to normal adaptive bilateral filter.

CONCLUSION

In this project, we presented an adaptive bilateral filter using high boost filtering. The filter out performs the adaptive bilateral filter in noise removal. At the same time, it renders much sharper images than the conventional bilateral filter does. As compared other filters/algorithms the high frequency components of image are emphasized without eliminating low frequency component. This proposed filter is more efficient to implement, and provides a more reliable and more robust solution to slope restoration. As a result, the overall quality of the restored image is significantly improved.

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