ISSN 2320 - 2602
Volume 3, No.1, January 2014
International Journal of Advances in Computer Science and Technology
Available Online at http://warse.org/pdfs/2014/ijacst09312014.pdf

Direction Based Adaptive Weighted Switching Bilateral Filter for Removing Mixed Noise in Color Images

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ABSTRACT

In order to retain the original image by removing the noise data from images becomes major important issue in image processing. Several filtering methods have been proposed in earlier work to remove noise data, one of the filtering method is bilateral filter can outstandingly decrease preservative noise without changing of original image, however it not succeed to reduce impulsive noise. To overcome the problem of bilateral filtering methods enhanced bilateral filtering have been anticipated in earlier years ,whereas each and every pixels values are evaluated using dissimilar basis. Improved bilateral filtering methods current pixel values only analyzed where other pixel values are not measured it degrades the performance of the accuracy in noise data .Improve the accurateness of the organization by executing the weighted median filter in the direction of re-establish images degraded by noise. Neighborhood of a pixel is classified intothree ways smallintermediate and extremely regions based version. Based on the regions the weight values are assigned to the median filter working intended for denoising is strong-minded and MRF supported segmentation was achieved .In addition, switching method permits the make use of dissimilar weights intended for dissimilar regions supported on contained information. The anticipated algorithm can be appropriate to digital images with the majority of the superior particulars of the picture be frequently conserved. The replication examination would show that the proposed technique is high-quality for noise decrease and image renovation.

Keywords: Image denoising, Segmentation, Bilateral filter, Improved Bilateral filter, Markov Random Field (MRF) segmentation.

1. INTRODUCTION

In digital image processing methods introduce the image acquirement methods and adds several types of noises to improve the accuracy result. Image denoising is additional important than some supplementary responsibilities in image dispensation, psychoanalysis and purpose. Moreover the noisy images generate disagreeable illustration superiority; it as well inferior the visibility of low down difference substance. Therefore noise elimination is necessary in digital imaging purpose in organize to improve and get better very well information that are concealed in the information. In numerous occurrences, noise in digital images is established in the direction of preservative in environment with standardized authority in the complete bandwidth.

In frequent conditions, images repeatedlyknowledge from the version of assorted noise and preservative noise. For instance, the failure and responsibility in camera sensors, extraordinary remembrance locality in hardware and distinctive instability, are the frequent reason for impulsive noise, where the thermal consequence of a variety of electronic circuit and photo-electronic strategy determination characteristically establish preservative noise to images [1–4]. It is understandable that noise contamination will considerably reduce the illustration quality and apprehension the show of image-processing procedure. Consequently, image filtering is essential or even essential for any picture submission organization and is individual of the majority widespread image-processing responsibilities.

Noises forever corrupt the usual images as the imagery are broadcasted or replacement beginning imperfect diffusion channel and strategy. The failures sourced frequently formulated it complicated to be familiar with what an absolutely unique image. Purposely, noises critically influence the result of image processing purpose, including ground wrap categorization, image watermarking, face identification and etc.., consequently, it is significant to acquire purge out of the noise beginning the degraded image.

In universal, the noises in a degraded image don't erased entirely, at the same time as the majority of noise elimination technique move toward next to unique reliability of the noised images. Salt-and-pepper is being of the significantaspiration noises with the intention of being the majority widespread in imagery. Assortment of procedures has been estimated to reduce these noises in image. Median filters are extensively consideration to be enhanced ones for eliminating impulse noises because they can moreover protect the boundaries in a degraded image. The filters can be carrying out added successfully by means of following process, such as preprocessing, image segmentation, classification etc. On the other hand, due to the ambiguity of the division of the impulse noises, it is complex to discover

an arithmetical representation to investigate and acquire purge of them.

In several conditions, images frequently endure beginning the corruption of mixed noise combination of impulsive and preservative noise. Denoising is a procedure of restraining noise whereas preserves the dependability of the image. In the accessible representation of filtering practice might be caused appositefor the reason that of noise data present in the current image and elimination noise data from image also becomes difficult. Noises concern the perceptual superiority of the image, falling not simply the admiration of the image other than additionally the performance of the task was anticipated. The consequences demonstrate this technique is high-quality for noise reduction and image re-establishment particularly in elevated stage noisy images. Get better the excellence of the recovery image not including noise we planned a weighted median filter and separate the category label pixel assessment into low, high and medium with MRF based image segmentation was performed measures the result.

2. BACKGROUND STUDY

In image denoising technique it is multifaceted to restrain average weighted Gaussian noise data beginning images since it compensationin the region of every one pixel in an image representation [4]-[5]. In denoising present is constantly a substitution among noise inhibition and conserving definite image discontinuity. To eliminate noise not including unnecessary smoothing of significant particulars, a denoising performance requirements toward be present spatially adaptive. Dissimilar procedures are second-hand depending going on the noise representation. Appropriate to sparsity, wavelet representation based edge recognition and multi declaration belongings with noise filtering for sparsity adaptive method used in earlier work [6].

Lately the majority fashionable denoising technique is the bilateral filter is its capability to conserve edges althoughresponsibilityin spatial smoothing filter domain.The bilateral filter is a vigorous filtering method, while the values of weight for each and every pixel are dissimilar level of intensity [4]. The majordifficulty in Bilateral Filter (BF) is its inability in elimination of noise. The subsequentdisadvantage of the BF iswith the intention of it fabricates stairwayconsequence and it is moreoversolitarydeclaration in personality.

Gaussian noise (GN) isconsistentlydisseminatedin excess of the indicator. Every pixel within noisy image is the amount of accurate pixel importance and anindiscriminate Gaussian distributed noise assessment [8].Several types of noise are present in previous years we define these noise and individual noise problems in below:

Salt and Pepper is one of the type of impulse noise and is furthermorealso called as intensitypoint. It is normally reason appropriate to miscalculation inside communication. It hassimply two probableprinciples, a high assessment and a low assessment. The possibility of every ischaracteristicallya smaller amount than 0.1.

The degraded pixels are situated on the other hand to smallest amount or to greatestidealsgenerous the picture Salt and Pepper likemanifestation. The unaltered pixels stay behindunaffected [8]. Speckle noise [9]-[10] is one of type of noise under multiplicative. These types of noise happen in approximately all consistentscheme such as SAR images etc. The foundation of this noise is random interventionamong the consistentproceeds [8].

On the other hand, the abovementionedtraditional filters are merelyeffectual in eliminate impulsive noise and deprived in suppressing additive noise. For additive noise, a delegated scheme is based on the Bilateral Filter (BF) [11].By concurrentlybearing in mind the arithmeticalfamiliarity and photometric correspondence of the nearest pixels, the BF can exceptionally suppress additive noise and at the similarinstancenot includingof smoothing edges and their details.

An impression of filtering based methods for color images with vector based filtering approaches was discovered in [12–14].It havebeexpansivelyconsidered and numerousdisparity and enhanceddescription have been proposed [15–17].In adding together to suppression of noise, the BF procedure is furthermore second-hand for edge recognition and image improvement [15, 16].

In [17], high-speed BF algorithms are discussed. In [18] and [19], the BF is joined by means of wavelet disintegration to appearance an original image de-noising technique. In adding together, the difficulty of selecting the most favorable smoothing constraint for the BF is moreoverconsidered in the two papers. By using the restrictedstageconsistency to calculate the perceptual importance of signals, an adaptive BF method is obtainable in [20].

3. IMPROVED BILATERAL FILTER AND DIRECTION BASED MEDIAN FILTER WITH MRF

Enhanced Bilateral Filtering techniquedesigned forelimination of diverse noise beginning color images is developed. By investigating whether the modern pixel is a probabledesire or not, the anticipatedtechniquemake use ofdissimilarbasis: the present pixel itself or the vector center, to obtainmeasurementinside the BF accomplishment. That is, whilst the present pixel is established to be a achievabledesire, the vector median of the color pixels within the filter casement is preferred as the foundation of the BF ; or else, as similar as the conventional BF, the innermost pixel remainderbecause the support. Inside this technique the yield of the anticipated BF is principallystrong-mindedthrough the vector median at what time the middle pixel is a probable impulse and conquered by the middle pixel itself at what time the middle pixel is not

a probabledesire. Therefore, the outstandingbelongings of the BF, i.e., containment of additive noise not includingof smoothing edges and information, and the capability of eliminating impulsive noise, are accomplished concurrently by the anticipatedtechnique.

In adding together, a novel weighting purpose is established to the anticipated resolution, which is experimentally supplementary successful than the conventional Gaussian weighting purpose second-hand in the innovative BF system. Consider a improved bilateral filter with noisy images, permit$x(i,j)$represents the noisy color vector at location(i,j). Presumeto the filter window is of size N

$$N = (2N_1 + 1) \times (2N_2 + 1),$$

And represents the filter window centered at presentlocation(s,t) as,

$$\Omega(s,t) = \{(i,j) \in [s - N_1, s + N1] \times [t - N_2, t + N_2]\}$$

After that the result of the BF on pixel $x(s,t)$can be prepared as follows:

$$y_{BF}(s,t) = \frac{1}{r_{BF}(s,t)} \sum_{(i,j)\in\Omega(s,t)} \exp\left(-\frac{(s-i)^2 + (t-j)^2}{2\sigma_s^2}\right) \cdot \exp\left(-\frac{\|x(s,t) - x(i,j)\|_2^2}{2\sigma_s^2}\right) x(i,j)$$

wherever$\|.\|_2$ denotes L_2 norm or the Euclidean distance, $\sigma_s$and $\sigma_r$are the average deviations of the spatial sphere and range sphere Gaussian filters toused to manage the fall-off of weights in spatial sphere and range domains, correspondingly, and

$$r_{BF}(s,t) = \sum_{(i,j)\in\Omega(s,t)} \exp\left(-\frac{(s-i)^2 + (t-j)^2}{2\sigma_s^2}\right) \cdot \exp\left(-\frac{\|x(s,t) - x(i,j)\|_2^2}{2\sigma_s^2}\right)$$

is the normalization aspect that guarantee the amount formed of the BF not go further than the assortment of color controlvalue. Because the weight value of each and every pixel values are drops gradually through the raise of its spatial domain and dissimilarity among the pixel values, the result of every pixel in the BF essentially depends on the innermost pixel itself and the nearby pixels so as toclose up to the innermost pixel in spatial location and color assessment, whileindividualsso as toconsiderablydivergebeginning the innermost pixel in color distribution determinationcontainextremelylittle weights and consequentlycontainsmallinvolvement to the filter's output. Consequently, if the innermost pixel is a thin-line pixeldetermination be dominantly resolute by the pixels all along this procession, therefore the edge arrangement is conserved. On the additionalhand over, conversely, if the innermost pixel is an inaccessible impulse, output of the improved bilateral filter determination mostlyresolute by the innermost pixel itself, for the reason that the color dissimilarityamong the nearby pixels and the innermostpixel are extremelyhuge and thus these nearby pixels will includegreatlylesser weights evaluated to the innermost pixel. This is the motivation why the BF is able tooutstandingly suppress additive noise not including smoothing edge informationexcept fails in the direction oftake away impulsive noise.Let $y(i,j)$symbolize the output of the enhanced BF at location(i,j). Because the pixels in the present pixel $x(s,t)$have been developed while processing$x(s,t)$, the filter window $\Omega(s,t)$ be capable ofmoreoverestablish the subsequent pixels:

$$\Gamma(s,t) = \begin{bmatrix} y(s-N_1,t-N_2) \dots y(s,t-N_2) \dots y(s+N_1,t-N_2) \\ y(s-N_1,t) \dots \dots \dots . \ x(s,t) \dots \dots \dots (s+N_1,t) \\ x(s-N_1,t-N_2) \dots . \ x(s,t-N_2) \dots x(s+N_1,t-N_2) \end{bmatrix}$$

Inside the conventional bilateral filtering technique, whilepresent pixel $x(s,t)$is an inaccessible impulse, its color dissimilaritybeginning the neighbors force be huge, and thus the weights values for each and every pixel determination be little. This wayto the nearby pixels determination have smallinvolvement to the filter's output, which indicateto the filter is fundamentallyresolute by the present pixel itself. Subsequently the impulsive noise left over sun affected. To conquer this difficulty, primary, the present pixel x(s, t) is approximatelymoderator whether it is a probable impulse or not. If x(s, t) is established to be a probable impulse, the vector median is selected as the bottom to substitute the middle pixel x(s, t) to obtainmeasurement in the BF achievement and thus the impulsive noise determinationexistsuccessfullyconcealed or else, when x(s, t) is measured as a non-impulse pixel, the regularBF process is achieved and thus the outstandingassets of the Bf for suppressing additive noise and conserving edges, reservedundamaged.

Noises concern the perceptual superiority of the image, falling not simply the admiration of the image other than additionally the performance of the task was anticipated. To conquer the problem of enhanced BF methods to categorizes of every pixel and founding the noises for individual pixels with different categorizes. Markov random fields (MRF) model is one of the well efficient methods for image segmentation with different pixel level categorization to remove noise from images and recognizes which part of the pixel is damaged highly. The MRF representation is generally based on the discovering of unique color identification for each and every noise images. The representation of the pixels for noisy images decreases the error rate among the input and the output, whereas at the equivalent instance reducing the dissimilar among the color pixels as well as neighboring pixels in the yield. MRF

algorithm designed for the principle of denoising with medical images. It is used to implement for each and every user noise input images to correct the contribution consideration and rapidly accepts feedback.

The consumer thus accepts feedback on the consequence of restriction alteration approximately instantaneously and successfully decides on the restriction to offer the most excellent harvest image. Every one pixel in the representation has a color and a position of pixels which bespecific as the neighbors of the pixel. The region of a pixel is classified into small corrupted, usually corrupted and seriously corrupted regions.

From this classification the values of each and every pixel weight values are determined for filtering process, and then MRF algorithm performs the segmentation for each and every input image with information with diverse classes of pixel values in expressions of intensity. The switching method is second-hand for make use ofdiverse weights for dissimilardistrict. The anticipated algorithm is appropriateused for digital images by means ofthe majority of the very wellinformation of the image befrequentlyconserved.

Restricted informationdesigned forexamining corrupted value of pixels to non-corrupted value of pixels inside an image. We includepremeditateddisparityprocedureslstand on the restrictedarithmeticalcomputationtobe dependent on medium based information. Therefore, algorithms premeditated based on measures are mentioned above to recommendimprovedaccurateness in the division and classification of diversecategory of noise.

$$\rho = \frac{1}{N}\sum_{n=0}^{N}(x_n - Median\{x_n || n\epsilon[1, \ldots\ldots N]\})^2$$

The preliminary threshold "p_s" is resulting by creating histogramsfor all variation level pixels inside the image. This threshold distinguishes among the non-homogeneous regions and homogeneous regions. The subsequently variation quantify is working to distinguishamongreasonable to elevated variation pixels based on the threshold measure"p_g". The appearancerelated with this threshold evaluate is specified as,

$$\rho_g = \frac{1}{i * j}\sum_{k=1}^{i}\sum_{l=1}^{j}\rho(k,l)$$

"p_g" indicates the second threshold measure
"i" & "j" indicates the size of the image
" p" indicates the variation measure of each pixel
"N" indicates the number of pixels in the window

The difference of the pixels classified into three ways :

1. Low Variation Pixels $\rho < \rho_s$
2. Moderate Variation Pixels $\rho_s < \rho < \rho_g$
3. High Variation Pixels $\rho_g < \rho$

The basic classification of the pixels is into three groups based on the threshold measure i.e. as follows

$$\alpha = \frac{Max(p_h^2)}{Min(p_v^2)}$$

By means of, restricted dissimilarity based median information of adjacent pixels provide stronger establishment concerning the pixel in thought. In adding together, it recommends scope for inaccuracy by incorporating technique to eliminate involvement of corrupted pixels to neighborhood pixels. It is a familiar fact with the intention of directional dissimilarity evaluated based median examination make available all the way through categorization based on direction with admiration to middle pixel. The capability to selectively categorize both corrupted to non-corrupted pixel permit the decrease in false detection rate for pixels. The result of each and every filtering result was shown below.

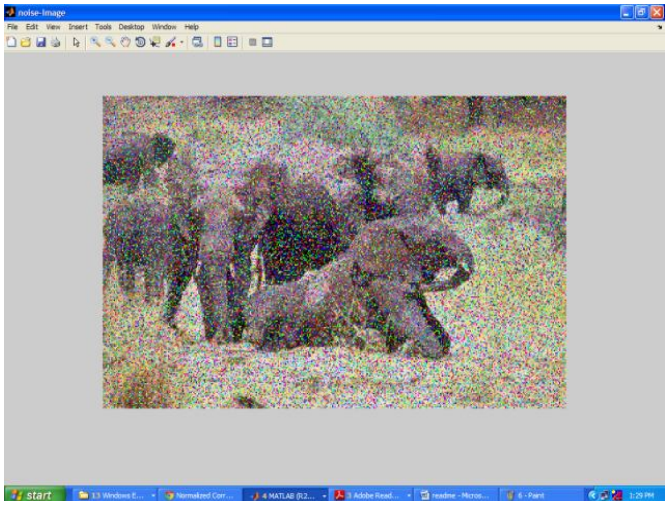

Figure 3: 1: Original noise input image

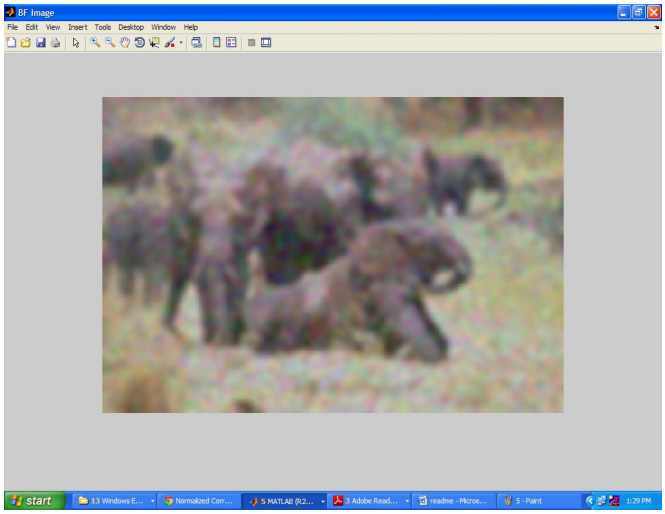

Figure 3:2: Bilateral filtering for noise input image

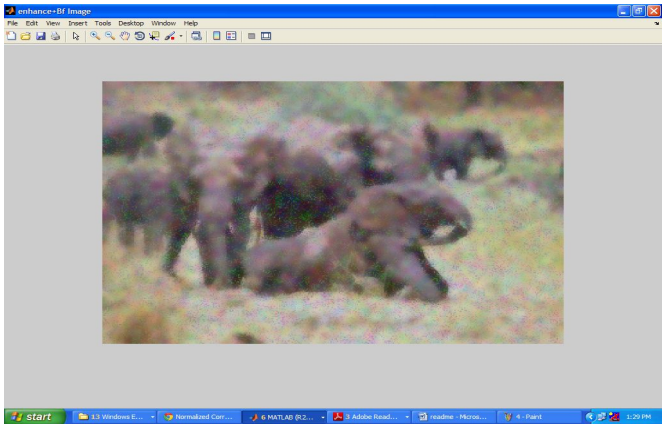

Figure 3:3: Improved Bilateral filtering for noise input image

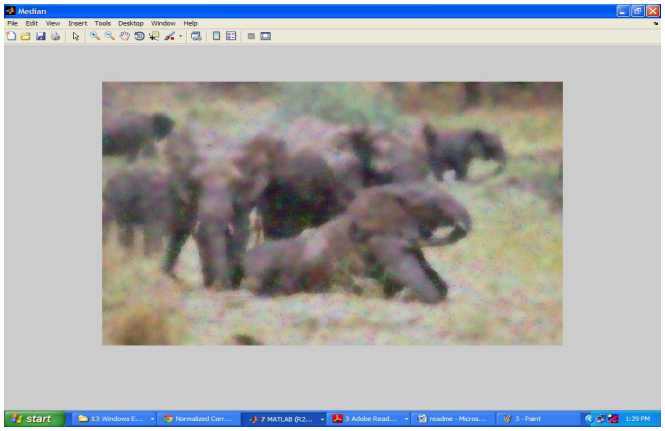

Figure 3:4: MRF based median filtering for noise input image

4. EXPERIMENTAL RESULTS

In this result measure the performance of each and every filtering method for noisy input image, the majority of them are initiallyanticipated to eliminate noise whereas preserving superior details and geometrical construction in the unique image.It is well identifiedto the denoising performance of each filtering methods frequentlycalculated in conditions of peak signal-to-noise ratio (PSNR), Mean Square Error (MSE) and Mean Absolute Error (MAE). A higher PSNR would usuallysignifyto the restorationof the original input image with higher quality.To make best use of the PSNR, asubstitute approach is to reduce the mean square error (MSE) and Mean Absolute Error (MAE) which can be predictablecorrectly.

4.1. Peak Signal-To-Noise Ratio (PSNR)

The purposeusual of the performance of these filters is the PSNR of the restored images formerly corrupted at various levels of noise ratio. With admiration to the noise-free image A, the definition of PSNR for a concluding restored image Z sized $M \times N$ is

$$PSNR = 10log_{10}\frac{255^2}{MSE}$$

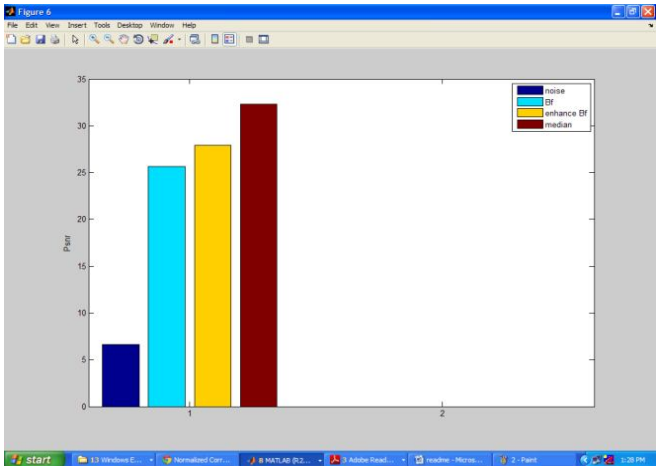

Figure 4:1: PSNR vs. methods

In the figure 4.1 shows the PSNR value results of Bilateral filtering, Improved Bilateral Filtering and MRF based Median filter. The higher value of PSNRfor MRF-based median filter point towardsthe dropping level of noise ratio and high quality of results.

4.2. Mean Square error (MSE)

Means square error is defined as the evaluation of the less error value for noise images and it is defined as,

$$MSE = \frac{\sum_{x=0}^{M-1}\sum_{y=0}^{N-1}(A(x,y) - Z(x,y))^2}{MN}$$

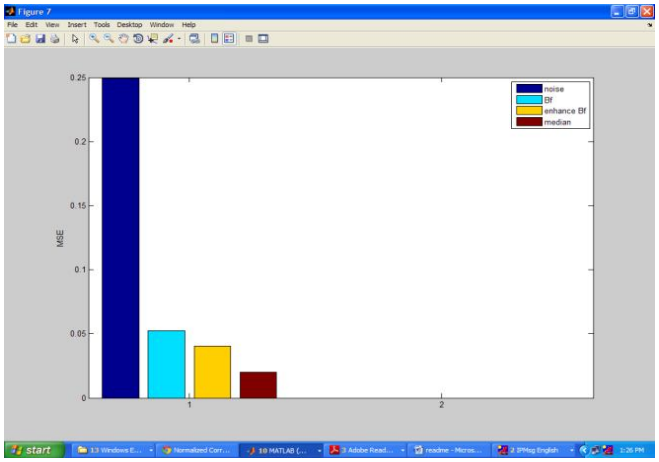

Figure 4:2: MSE vs. methods

In the figure 4.2 shows the MSE value results of Bilateral filtering, Improved Bilateral Filtering and MRF based Median filter .The lesser value of MSE value for MRF-based median filter point towardsthe dropping level of noise ratio and high quality of results.

4.3. Mean Absolute error (MAE)

Mean absolute error (MAE) is a magnitudesecond-hand to calculate how close anticipate are to the ultimateconclusion. The mean absolute error is specifiedby means of,

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|f_i - y_i|$$

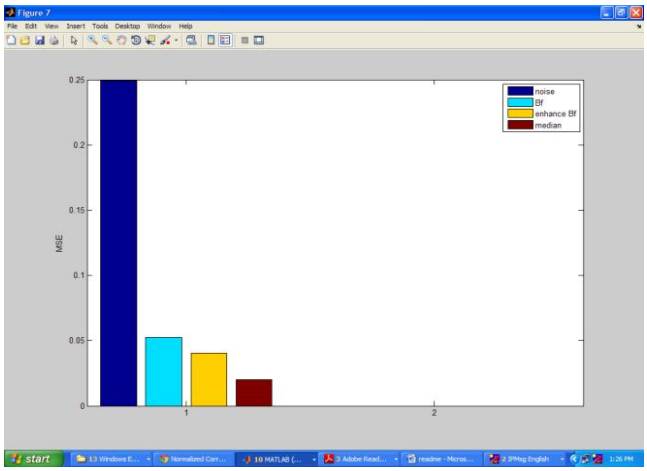

Figure 4:3: MAE vs. methods

In the figure 4.2 shows the MAE value results of Bilateral filtering, Improved Bilateral Filtering and MRF based Median filter .The lesser value of MAE value for MRF-based median filter point towardsthe dropping level of noise ratio and high quality of results.

Table 4.1: Performance comparison of filtering methods vs parameters

Parameters vs. methods	**Noise**	**Bilateral Filtering**	**Improved Bilateral Filtering**	**MRF-based Median Filtering**
PSNR	7	26	28	33
MAE	2.1	1.45	0.3	0.2
MSE	0.25	0.05	0.04	0.02

5. CONCLUSION AND FUTURE WORK

In this paper proposed a direction based filtering approach to measure the results of pixel values and decreases the numeral of pixels to be performed earlier than the replacement of noisy pixel values. Founding the exact noisy pixel values are categorized into three ways based on these categorizes remove the noise from images and majorly focus to higher corrupted pixel intensity level by consideration of adaptive MRF algorithm with filtering is effectual at denoising medical images .The MRF based median filtering technique is extremelywell-organized, significancewith the intention ofoutcome are fashionedsubsequentlyspeedily that a usual medical imaging by means of applying the dissimilar pixel values to everythe majorityof satisfactory segmentation in approximatelyactualinstance interactively.

In future work we also planned to apply these methods to other types of applications than medical imaging such as image matting, haze removal, and image colorization.

REFERENCES

1. K.N. Plataniotis, A.N. Venetsanopoulos,**"Color Image Processing and Applications"**, *Springer, Berlin*,2005.
2. Z. Ma, H.R. Wu, B. Qiu, **"A robust structure-adaptive hybrid vector filter for color image restoration",***IEEE Trans. Image Processing* 14 (12) 1990–2001,2005.
3. E. López-Rubio ,**"Restoration of images corrupted by Gaussian and uniform impulsive noise",***Pattern Recognition* 43 (5) 1835–1846,2010 .
4. H. Zhou, K.Z. Mao, **"An impulsive noise color image filter using learning-based color morphological operations"**, *Digital Signal Process*. 18 (3) 406–421,2008.
5. M.Vijay, L.Saranya Devi, M.Shankaravadivu and M.Santhanamari**"Image Denoising Based On**

Adaptive Spatial and Wavelet Thresholding Methods",*IEEE-International Conference On Advances In Engineering, Science And Management, (ICAESM -2012)* March 30, 31, 2012 161

6. R.C. Gonzalez and R.E. Woods "**Digital Image Processing"**, *2nd ed. Englewood Cliffs,* NJ: Prentice- Hall; 2002.
7. S.G.Chang, B.Yu and M.Vetterli,"**Spatially adaptive wavelet thresholding with context modeling for image denoising,"***IEEE Trans. on Image Processing,* Vol.9, No.9, pp. 1522-1531,2000.
8. JappreetKaur, ManpreetKaur, PoonamdeepKaur, ManpreetKaur,**"Comparative Analysis of Image Denoising Techniques",***International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459,* Volume 2, Issue 6, June 2012.
9. Gagnon, L., **"Wavelet Filtering of Speckle Noise-some Numerical Results",***Proceedings of the Conference Vision Interface,*Trois-Reveres.
10. Goodman, J. W **"Some fundamental properties of Speckle",***J. Opt. Soc. Am.*, 66, pp. 1145–1150.
11. C. Tomasi, R. Manduchi,**"Bilateral filtering for gray and color images"**, *Proceedings of IEEE 6th International Conference on Computer Vision (ICCV),* Bombay, India, pp. 839–846, 1998.
12. R. Lukac, K.N. Plataniotis , **"A taxonomy of color image filtering and enhancement solutions",***P.W. Hawkes (Ed.), Advances in Imaging & Electron Physics, vol. 140,* Academic Press, San Diego, CA, pp. 187–264,2006.
13. B. Smolka, A.N. Venetsanopoulos, **"Noise reduction and edge detection in color images",***R. Lukac, K.N. Plataniotis (Eds.), Color Image Processing: Methods and Applications,* CRC Press/Taylor & Francis, pp. 75–102,2006.
14. M.E. Celebi, H.A. Kingravi, Y.A. Aslandogan**"Nonlinear vector filtering for impulsive noise removal from color images"**, *J. Electronic Imaging* 16 (3) 033008, 2007 .
15. B. Zhang, J.P. Allebach,**"Adaptive bilateral filter for sharpness enhancement and noise removal",***IEEE Transaction on Image Processing* 17 (5) 664–678,2008.
16. W.C. Kao, Y.J. Chen, **"Multistage bilateral noise filtering and edge detection for color image enhancement",***IEEE Trans. Consumer Electron.* 51 (4) 1346–1351,2005.
17. G. Guarnieri, S. Marsi, G. Ramponi,**"Fast bilateral filter for edge-preserving smoothing",***Electron. Lett.* 42 (7) 396–397, 2006.
18. M. Zhang, B.K. Gunturk**,"A new image denoising method based on the bilateral filter",***Proceedings of IEEE International Conference on Acoustic,Speech and Signal Processes,* Las Vegas, NV, USA, pp. 929–932,2008.
19. M. Zhang, B.K. Gunturk, "**Multiresolution bilateral filtering for image denoising ",***IEEE Transaction on Image Processing* 17 (12) 2324–2333,2008.
20. A. Wong ,**"Adaptive bilateral filtering of image signals using local phase characteristics",***Signal Processing* 88 (6) 1615–1619,2008.