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A Hybrid BM3D Filter And Adaptive Median Filter For Gaussian Noise Removal In Gray Scaled Images

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Abstract: Noise reduction is a very important issue in image processing. Block matching 3D (BM3D) method has shown powerful image denoising capacity. Block-matching, processing and aggregating the three-dimensional arrays created from noisy images accomplishes this. Block Matching 3 is an effective method of denoising that follows a non-local technique is the Dimensional Method. It uses two operating phases, each of which has three execution phases, such as collection, collaborative filtering and aggregation. This approach offers good output for Gaussian noise.

Keywords: *Image Processing, Gaussian noise, filtering techniques, BM3D, median filtering*

I.INTRODUCTION

Various forms of noise, including Gaussian white noise, salt- and pepper noise, signal-dependent noise, impulse noise, and so on, are frequently polluted by digital photos. The reduction of noise in a picture has a range of trade-offs. In addition to make informed decisions, it is also important to take into account the features of the noise and the information in the images. In the literature, there are a variety of denoising strategies published [1]. These methods involve spatial filtering, domain filtering transformation, modeling of wavelet coefficients, adaptive strategies for info, etc. As in the following description, image denoising could be developed. Let the noise-free image be B and the corrupted image with Gaussian white noise [2] be A, i.e.,

$A = B + \sigma_n Z$ (Equation 1)

Where Z has a normal distribution N(0; 1) and on is the noise standard deviation.

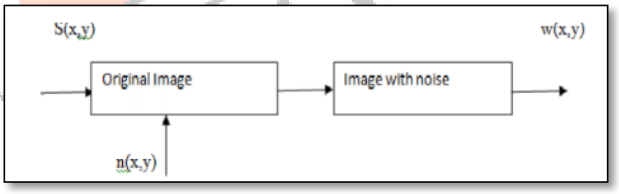


Figure 1: Noise Model [2]

The set or spectrum of monochrome (grey) colours, which spectrum from pure white on the softest end to pure black on the extreme side, is the grey scale. Only luminance (brightness) data and no color image are used in the grey scale; that is why peak luminance is white and zero luminance is black; a shade of grey is all in addition. That is why photos on the grey scale include only grey shades and no color[3].

The organized of the paper is in section II explains the BM3D Approach, In section III describes the literature review regarding noises, Section IV explains the objectives and the flowchart , Section V describes results and section VI explains the conclusion of the work.

II. BM3D Approach

BM3D is a recent non-local image modelling approach focused on the fact that an image in the transformation domain has a precisely sparse representation. It is possible to divide this method into 2 significant steps [4]. During collaborative filtering, the first's design the de-noised picture using hard thresholding and could be split into three small stages. Noise reduction is a very interesting subject in image processing. Block matching 3D (BM3D) method has shown powerful photo denoising capacity. Block-matching, processing and aggregating the three-dimensional arrays created from noise reduction accomplishes this. Block Matching 3 is an effective approach of denoising that follows a non-local technique is the Dimensional Algorithm. It uses two operating phases, each of which has three execution phases, such as collection, collaborative filtering and aggregation. Moreover the new 3D group is accessed by Wiener filtering instead of a pure threshold.

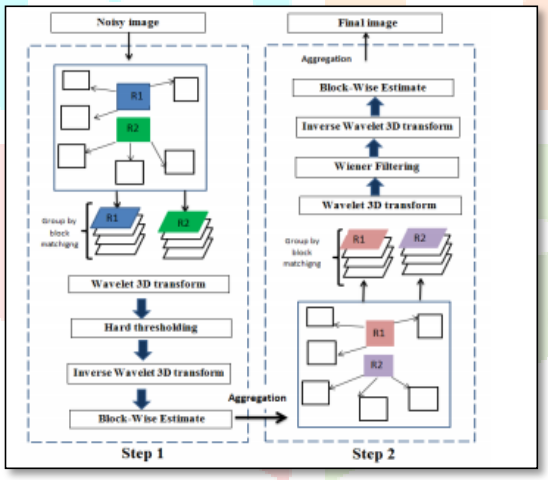


Figure 2: Diagram of BM3D Filter[5]

Algorithm of BM3D filter

Recognize a picture area D centered across the x(n, m)[5,6] pixel.

1 . Check for D 'areas that are close to the D region regarded. Notice that in the transform domain (commonly Hadamard / Walsh transform), this resemblance search is conducted. The threshold is contrasted with these transformation coefficients and those far below threshold are set to 0. To improve the search process, similar patches are identified to be equally identical to the patch considered.

2. It brings identical patches into the 3D matrix. The 3D matrix's 3D discrete linear transform is assessed. Transformation coefficients produced are thresholded and all coefficients below the threshold are discarded. Using inverse 3D transformation, temporary filtered blocks are produced. Note that separate 2D/1D transformations are used in practice for measurement purposes rather than the 3D transform.

3. These frames that have been filtered are restored to the image For each pixel, the method is conducted. Different numbers of various blocks relate to pixels. An aggregation of the filtered blocks could be done. The weighted aggregation coefficients are determined on the basis of the amount of transform coefficients in the 3D transformations above the threshold. More coefficients above the threshold mean that the blocks have more residual noise and vice versa, respectively.

4. Relative blocks are found for the filtered image from the previous rule.

5. Similar blocks from the 3D matrix.

6. The 3D transform is measured for the 3D matrix.

7.3D transform coefficients are filtered using the Wiener filter.

8. Inverse 3D filtering is assessed to acquire the final version of filtered patches.

9. These filtered patches are again aggregated to acquire the final estimate.

Steps 1-3 describe the system's first (coarse) run, while phases 4-9 reflect the fine method run implemented from the first 3 stages of the output.

Several advantages of BM3D are [6] Retaining textures, keeping strong visual quality, even for reasonably loud noises, using the non-locality method, and collaborative filtering that give benefit

over other filters. Wiener filtering enhances the accuracy and precision of the Wiener filter is attractiveness.

III.LITERATURE SURVEY

Song et al., [7] An suggested technique focused on pre-classification using the coefficient of variation proposes to decrease its high complexity. Also get two block subsets with various local structural details after pre-classification. For its blocks, size-adaptive reference block matching is implemented in the subset with complex adjustments, named structural area. The original size-fixed reference block matching technique is implemented in the sub-set with uniform variance, as termed flat area. The suggested technique will significantly decrease the BM3D system's crossing scope for matching and, if identical improve the similarity between the reference block size and the target block (the block to be processed) size. This would contribute to improved noise reduction with lower computational costs. Experimental results indicate that, with similar denoising efficiency to the original BM3D method, the computational cost of the adaptive method is reduced significantly.

Andrew et al.,[8] present a brushlet-based block matching 3D (BM3D) approach in this paper to denoise ultrasound imaging techniques cooperatively. And organize them on the basis of similarity by splitting the image into multiple blocks. Then a 3D image volume is generated by clustered blocks that share similarities. To eliminate noise in the frequency domain, brushlet thresholding is implemented for every amount. The amounts are aggregated and replicated globally upon fulfillment of independent filtering. Run our denoising system on synthetic images corrupted with additive or multiplicative noise to test our process. The findings show that, in accordance with known techniques, our technique could obtain excellent denoising efficiency.

Seddik et al., [9] A non-blind image restoration method using the Wiener parametric filtering and BM3D denoising strategy has been used in this work. First of all, the degraded image is deconvoluted by parametric Wiener filtering in Fourier space, and then it is smoothed by the BM3D process. The findings of the experiment are very important and illustrate the efficacy of the suggested approach.

Chen et al.,[10] To acquire denoised sub-images, perform Block matching 3D filtering (BM3D) on these subimages. By executing BM3D once more on little image patches, we then merge sub-images together and improve the discontinuous areas among the sub-images. In comparison with the bivariate wavelet shrinkage and the traditional BM3D approach, our experimental findings demonstrate the efficacy of this suggested approach inspite of Peak signal to noise ratio (PSNR). Our process, in addition to Gaussian white noise for signal based noise, it appears to be better than the bivariate wavelet shrinkage and the regular BM3D process.

Igor et al., [11] this research explains latest salt-and - pepper noise filtering for digital pictures. The shape of objects (especially edges) in images is not taken into account for almost all recent strategies for filtering this form of noise. For both gray scale and colour pictures, the research proposal BM3dDFilter accomplished is outstanding, exceeding current state-of-the-art by about 2 dB.

IV. PROPOSED WORK

The major objectives of our research are:

- To study numerous Filtering approaches for Gaussian noise removal in Gray Scaled Images.
- To present and applied the Hybrid filter with Adaptive median Filter and BM3D Filter for Gaussian noise removal in Gray Scaled Images.
- To contrast the suggested hybrid approach with existing approach focused on following performance parameters viz. Peak Signal to

Noise Ratio (PSNR), Structural Similarity Index (SSI), Root Mean Square Error (RMSE).

The methodology used in this research is seen in the figure 3:

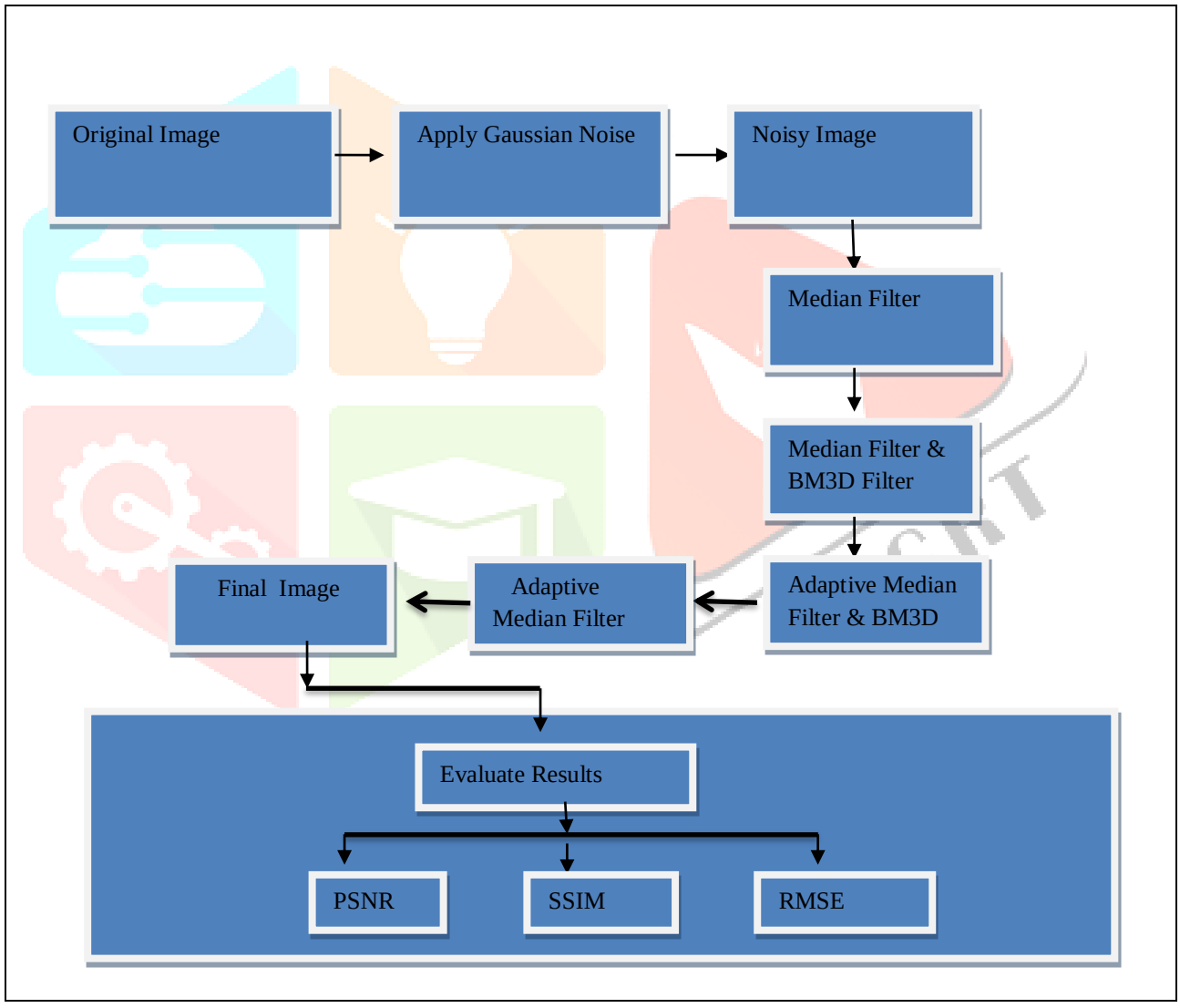


Figure 3: Flowchart of Proposed Methodology

V. RESULTS AND DISCUSSIONS:

For numerical computation, MATLAB is a high performance language. In a simple-to-use environment, it combines computation, visualization and programming, where issues are presented in common mathematical notation. It is an incremental innovation whose component of basic information is an ARRAY which needs no dimensioning. It

writes a code like C OR FORTRAN, in a non-interactive scalar language.

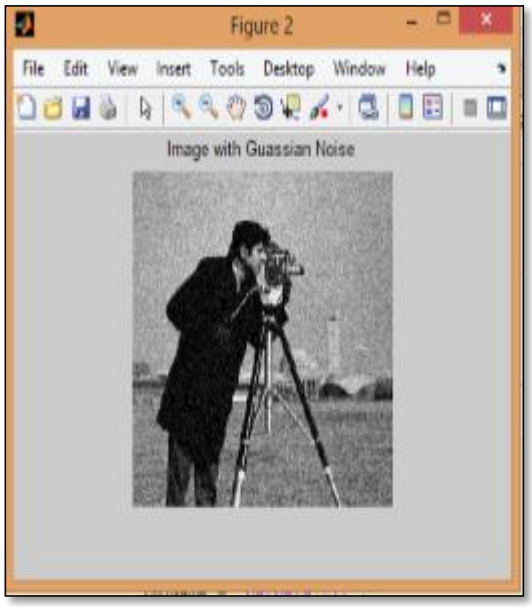
PSNR= 10 $\log_{10}\frac{255\times255}{MSE}$ (Equation 2)

MSE= $\frac{1}{m\times n}\sum_{i=1}^{i=m}\sum_{j=1}^{j=n}[I^{F}(i,j)-I(i,j)]^2$ (Equation 3)

To model the execution and study of the presented design using the MATLAB toolkit. And first take an input image of the cameraman to de-noise the Grayscale image as seen below:

Figure 4 :Input Image

And get the noisy image after introducing Gaussian Noise into the input image, as shown below, in which denoising is done.



First of all, by using the Median philtre using Matlab, the denoising of the above noisy image is achieved. Get the expected conclusions:

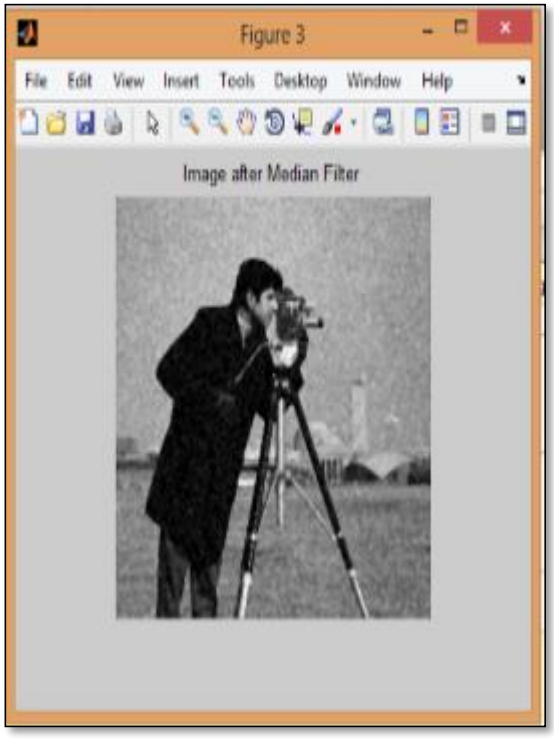


Figure 5 : (a) Noisy Image (b) Image after denoising using median filter and BM3D

Quantitative Analysis is also done using Matlab with the following parameters:

PSNR	MSE	MAX ERR	L2RAT	RMSE	MAE
69.5608	0.0072	0.5406	1.0336	0.0546	0.0072

Table 1: Results after using Median filter

Using Median BM3D filter , denoising of noisy image in fig is carried out using Matlab, can obtain the following outcomes:

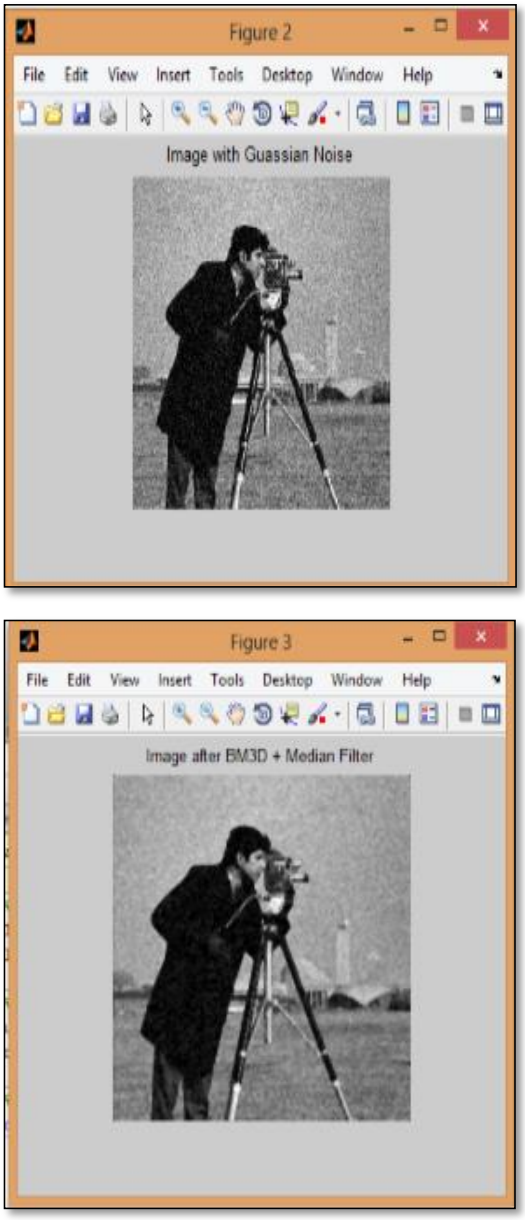


Fig 6: (a) Noisy Image (b) Image after denoising using median filter and BM3D

Quantitative outcomes acquired using mixture of Median filter and BM3D are shown below:

PSNR	MSE	MAXERR	L2RAT	RMSE	MAE
72.8721	0.0034	0.6096	1.0144	0.0579	0.0034

Table 2: Results after using Median filter and BM3D Filter

The noisy image in the figure is then denoted using the suggested Adaptive Median Filter and BM3D hybrid. The outcomes are as shown below:

Figure 7: (a) Noisy Image (b): Image after using Adaptive Median filter and BM3D.

Quantitative outvcomes acquired after Applying Adaptive Median Filter and BM3D filter are as follows:

PSNR	MSE	MAXERR	L2RAT	RMSE	MAE
73.3685	0.0030	0.5909	1.0124	0.0547	0.0030

Table 3: Results after using Adaptive Median Filter and BM3D

Comparison of PSNR values : In the graph below, the output of different denoising strategies used in this work is contrasted and shown. It is noted that, relative to existing works, the PSNR performance of the suggested hybrid philtre is enhanced. MSE decreases significantly in the situation of a hybrid filter , while MAE also decreases significantly in the situation of a hybrid system. This illustrates that are getting better results with respect of a hybrid filter.

Parameters	Median Filter	Median filter+BM3D	Adaptive Median Filter + BM3D
PSNR	69.5608	72.8721	73.3685
MSE	0.0072	0.0034	0.0030
MAE	0.0072	0.0034	0.0030

Table 4: Results of different parametes after using Median filter

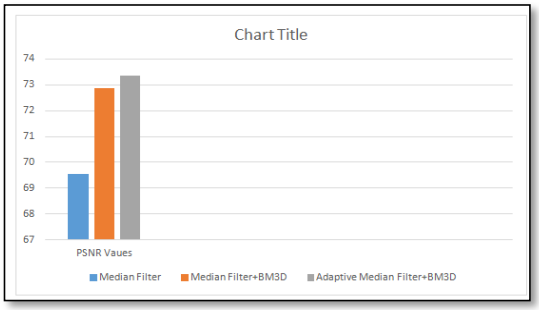


Figure 8 : Graphical representation of comparison of PSNR values of various techniques

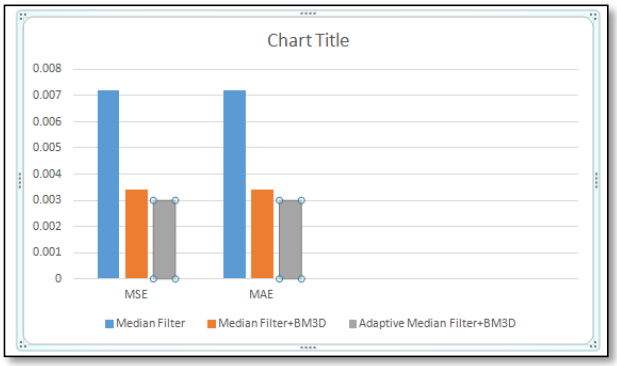


Figure 9: Graphical representation of comparison of MSEand MAE values of various techniques

VI.CONCLUSION

An extension of the Hybrid BM3D method to the decision-based / adaptive median filter performance for filtering Gaussian noise elimination in Gray Scaled Images was suggested in this paper. With regard to the decision-based / adaptive median filter, the BM3D filter with the suggested switching rule provides very noticeable and observable benefit. This work is a step in applying salt and pepper filter to non-local and shaping filter and other forms of impulsive disruptions from digital images. The proposed method could also be viewed as an addition to the difficult Gaussian noise condition of the hybrid BM3D. And have discussed the issue of the method of denoising gray-scale images in this research. Using the BM3D method with adaptive thresholding and weighted Wiener filtering, recovered the noisy images. The findings indicate that our approach accomplished better denoisation at different noise levels than the initial BM3D.

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