Enhancement in Morphological Mean Filter for Image Denoising Using GLCM Algorithm

Jyoti Choudhary and Alka Choudhary

***Abstract*— The morphological Mean Filter method is used to restore image corrupted by high-density impulse noise. A new method for de-noising is developed for MR (Magnetic Resonance) images which have Rician noise. This method is an enhancement of the Morphological Mean Filter (MMF). In this method, first Grey level Co-occurrence Matrix (GLCM) method is applied to noisy images and then the MMF method is applied to remove noise from the image. Experimental results show that the Proposed method effectively removes the noise as compared to the MMF method.**

***Index Terms*—GLCM, impulse noise, morphological mean filter, noise removal, Rician noise.**

I. Introduction

Image denoising or Noise removal can be described as a procedure which is used for the removal of noise from a picture. The noise corrupts all the features of a picture during the acquisition procedure or transmission. The image denoising process maintains the quality of a picture. In the medical field, timely recognition of disease is necessary. The random noise affects the quality of images during image acquisition step. This results in unwanted outcomes and bad optical quality of a picture which lowers the visibility of low contrast objects. The extraction of concealed details, image data and recovery of fine details is essential for the removal of noise in the applications of medical imaging. These noise corrupted MR (Magnetic Resonance) images influence the medical diagnosis procedure. In general, various techniques are used for eliminating noise from an image. For denoising MR images, various algorithms are proposed earlier. In a good quality denoising tool, the noise suppression process should not affect the quality of an image and this process should not deteriorate the useful features of an image as well [1]. In the MR images, the boundaries are very important; therefore, the preservation of boundaries is very necessary for the denoising process.

These days different scanning techniques are used in numerous applications. These techniques improve spatial resolution, SNR, and acquisition speed. However, at the time of analysis, the noise present impacts the analytic and visual quality of MRI. There are several kinds of noises included in images. Among these, few commonly known noises are explained below:

Gaussian Noise: The image includes this noise at the time of image acquisition. For instance, the transmission noise, circuit noise, sensor noise, etc. caused due to low light. The spatial filtering is applied such that the noise present in the color image can be removed [2]. A noise has Probability density function [PDF] of normal distribution. This function is called Gaussian distribution as well.

Impulse Noise: Salt & Pepper noise or Spike noise are some other names given to the impulse noise. The malfunctioning of pixels within the camera sensors, usage of the noisy channel for communication, or the existence of faulty locations within the memory makes the image noisy. The image pixels do not connect to this type of noise.

Rician Noise: Due to the presence of this noise, a bias is included in the color measurements. Thus, there is an extensive alteration of the shapes and orientation within the diffusion tensor magnetic resonance images. Thus, due to the presence of Rician noise in images, huge impacts are caused by the attributes of images.

II. Related Work

In [3], the author compared outcomes of several earlier proposed mean & median filtration techniques and proposed a new method in conjunction with spatial adaptive masking filtration to remove impulse noise. In [4], depending upon the morphological and fractal techniques, 3D MR image was designed using segmentation and denoising approaches. The paper [5] proposed MCDnCNN model which removed the Rician noise from 3D MR images. The authors [6] developed edge-preserving denoising technique in the field of medical image processing. The various denoising techniques using Fusion of local and non-local filter [7], using Contourlet Transform and Threshold Shrinkages Techniques [8], using wavelets [9]-[11], non-local mean filter [12], and other techniques for denoising [13], [14] and enhancing the image [15]-[17] were proposed.

III. Proposed Algorithm

The proposed algorithm is used to remove Rician Noise from Magnetic Resonance Images (MRI). The proposed algorithm is an enhancement of Morphological Mean Filter [18] which is used to remove impulse noise from images. The proposed filter consists of two modules shown in Fig. 1: Feature extraction module and Noise filtering module. In the first module, Feature extraction module uses GLCM (Grey level Co-occurrence Matrix) [19] algorithm to calculate some features like similarity features, contrast factors, etc. These features are given as input to the second module, Noise filtering Module. The Noise filtering module uses the MMF (Morphological Mean Filter) [18] to de-noise the image.

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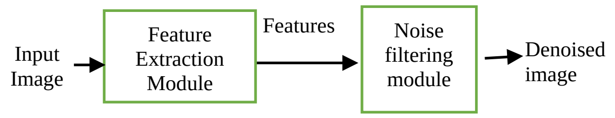


Fig. 1. Block diagram of proposed algorithm.

The steps of proposed algorithm are following:

Step 1: Input an image.

Step 2: Apply GLCM algorithm on input image to calculate similarity features.

Step 3: Input the original image and similarity features to MMF Algorithm.

Step 4: Apply MMF algorithm to get the denoised image.

The output of the proposed algorithm is denoised image.

IV. Experimental Setup

A. *Simulation Set-Up Parameters*

For the implementation and analysis of work, some set-up parameters are used which are given in the following Table I.

TABLE I: Set-Up Parameters

Parameter	Values
Tool Used	MATLAB
Tool Box	Computer Vision
Image Type	.bmp
Performance Metrics	PSNR, MSE, RMSE, SSIM, MSSIM
Number of images	Four

B. *Performance Metrics*

PSNR: The ratio of highest power of the signal to the power of noise is known as PSNR [16], [17].

MSE (Mean Square Error): Error existing among the denoised and genuine images is calculated here.

Following mathematical formula is applied to do so:

$$MSE = \frac{1}{n}\sum_{i=1}^{n} e_i^2$$

For the sampling of model errors, value of e is computed for the corresponding value of n.

RMSE (Root Mean Square Error): This value helps in calculating the root value of MSE map across the complete image. Following mathematical formula is used:

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n} e_i^2}$$

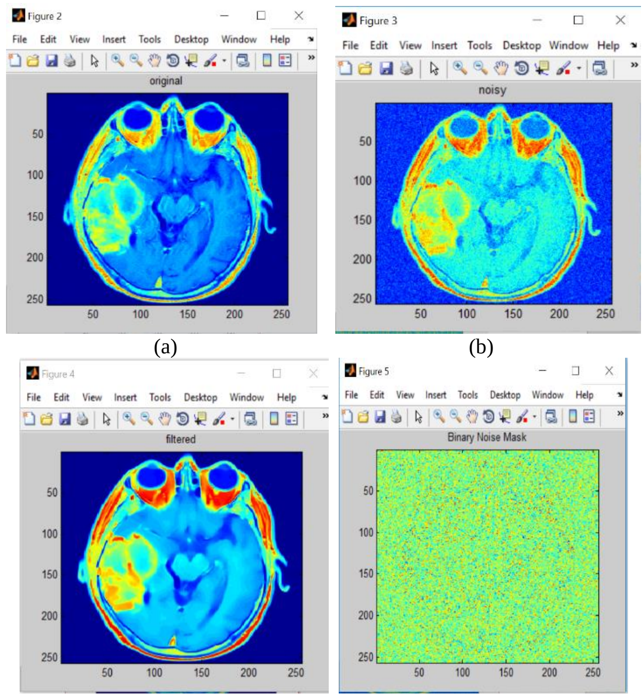
SSIM (Structural Similarity Index Method): The resemblance among two individual images is measured with the help of this technique.

MSSIM: This value is calculated by computing the mean value of SSIM map across the complete image.

V. Results

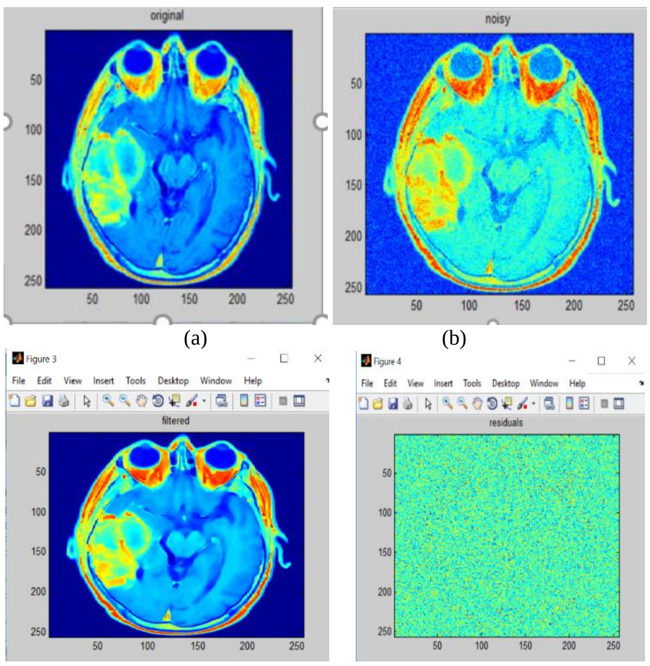
Both MMF filter and Enhanced MMF filter using GLCM are developed using MATLAB software. The results of MMF algorithm for one image i.e image1.bmp are shown in Fig. 2.

Fig. 2 (a) shows the input image for denoising Fig. 2 (b) shows the noisy image, Fig. 2 (c) shows the denoised image using MMF algorithm and in the Fig. 2 (d) residual is shown.



(c) (d)

Fig. 2. Results using MMF of image (image1.bmp) (a) Original image (b)Noisy image (c) Filtered image (d) Residuals image.



(c) (d)

Fig. 3. Results using Enhanced MMF using GLCM of image (image1.bmp) (a) Original Image (b) Noisy Image (c) Filtered Image (d) Residuals Image.

In the above Fig. 3 the results of Enhanced MMF using GLCM are shown. The person cannot differentiate easily by looking at output images or filtered images shown in Fig 2(c) and Fig. 3(c). Thus, other performance metrices are used to compare these two algorithms which are shown in Table II, Table III and Table IV. Thus, we can easily analyse these two algorithms by simply looking at tables and charts shown below.

TABLE II: COMPARISON OF PSNR VALUES

Method Name	Image 1	Image 2	Image 3	Image 4
Morphological Mean Filter	35.06	34.67	36.78	34.43
Proposed Method	43.98	40.12	44.67	40.67

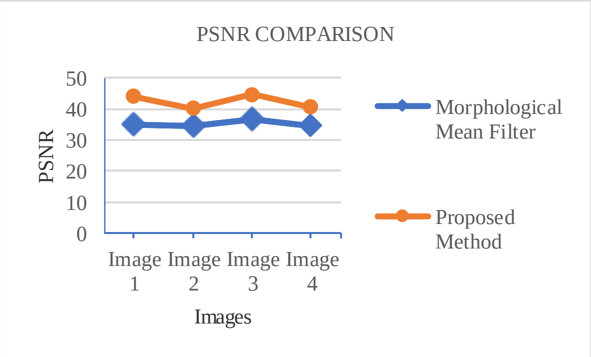


Fig. 4. PSNR comparison.

Table II and Fig. 4 shows the comparison of PSNR values achieved when applying proposed and existing technique MMF. The comparison shows the improvement of PSNR when applying proposed algorithm.

TABLE III: COMPARISON OF RMSE VALUES

Method Name	Image 1	Image 2	Image 3	Image 4
MMF Method	33.53	32.67	35.31	32.67
Proposed Method	26.54	24.31	25.78	28.89

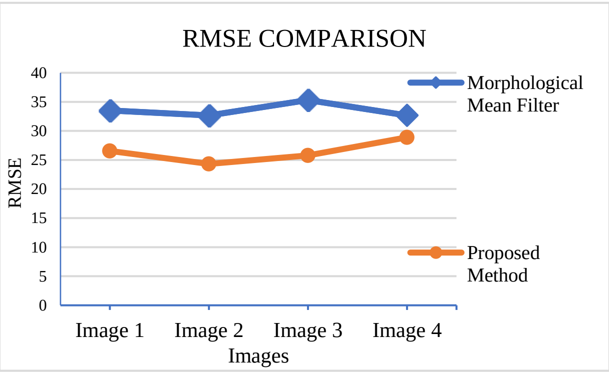


Fig. 5. RMSE comparison.

Table III and Fig. 5 show the comparison of proposed and existing algorithms in terms of RMSE values. The results show that there is reduction in the RMSE value after applying proposed algorithm.

TABLE IV: COMPARISON OF MSSIM VALUES

Method Name	Image 1	Image 2	Image 3	Image 4
MMF	0.7324	0.7578	0.7891	0.7981
Proposed Method	0.8145	0.8234	0.8425	0.8654

Table IV and Fig. 6 present a comparison of the MSSIM values of proposed and MMF algorithm. The results show that the proposed algorithm provides larger MSSIM value than MMF. Thus, proposed method is better than MMF.

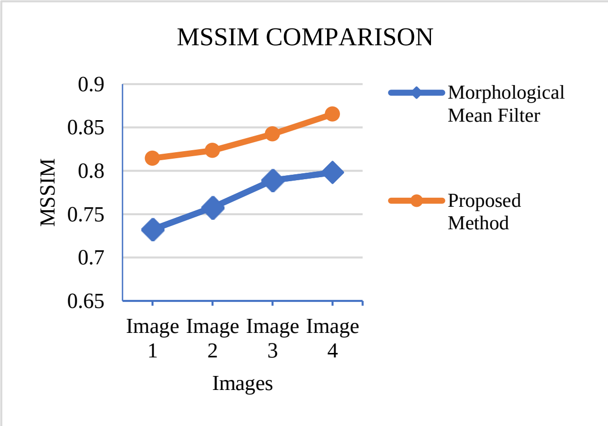


Fig. 6. MSSIM comparison.

VI. CONCLUSION

To denoise the images, a new method is proposed here. The proposed method is compared with MMF method on the basis of performance matrices like PSNR, RMSE etc. The quality of denoised image is improved by the proposed method.

VII. FUTURE WORK

The results and the outcomes of the proposed work can be utilized for analyzing the trustworthiness of CT scan images. The proposed algorithm can be compared with several other de-noising algorithms.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Jyoti Choudhary conducted the research; Alka Choudhary wrote the paper and did review and editing of manuscript; all authors had approved the final version.

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