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Analysis for Image Quality Improvement using Denoise Filtering Techniques

Pranali Turkhade[1], Prof. U.W. Hore[2]

P.G. Student, Electronics and Telecommunication Department, P.R. Patil College, Amravati, India [1]

Professor, Electronics and Telecommunication Department, P.R. Patil College, Amravati, India[2]

Abstract: This paper work describes the different denoise techniques for the removal of impulse noise. The Image denoising is the manipulation of the image data to produce a visually high quality image. Image Enhancement is one of the most important and difficult techniques in image research. The aim of image enhancement is to improve the visual appearance of an image or to provide a better transform representation for future image processes. At present there are a variety of methods to remove noise from digital images. Filter techniques are mainly used for de-noising, smoothness and sharpening of images. We are designing a new modified decision based un symmetric and Symmetric trimmed median filter for removal of these different noises by using median filter, Adaptive median filter, and Decision based Adaptive median filter. Most of the previously known techniques are applicable for the denoising of images corrupted with less noise density. Here a new decision based technique has been presented which shows better performances than those already being used and the new proposed algorithm will definitely protect the image from noise and distortion. In this paper we present different denoise filtering techniques for image quality improvement and this concept is applied to the different images and compares their performance parameters such as MSE, PSNR, correlation etc.

Keywords: Impulse Noise, Non Linear Filters, MSE, PSNR, Correlation.

I. INTRODUCTION

Image quality improvement is related with the field of image processing. The digital image contains important information in the form of object and text that can be used for various purposes like object recognition, face recognition and text recognition. In most of the applications, under pre-processing phase image denoising techniques are involved to process image such that its visual quality can be improved. After the denoising, the improved quality image can be used for further processing. The aim of denoising technique is to remove unwanted signals from theimage while saving important information. The noise in image is a disturbance that distorts the information and decreases the quality of the image. The noise is introduced in the image due to various reasons such as the imaging sensor may be affected by environmental conditions or due to insufficient Light levels and sensor temperature may introduce the noise in the image and another reason is interference in the transmission channel may also corrupt the image.

One of the most important areas of image restoration is that cleaning an image occurring by noise. In image processing field the goal of reducing noise is to eliminate noisy pixels Corruption of images .The noise is usually divided into Gaussian noise, the balanced noise and the impulse noise. One of the most common noise types which corrupt images during transmission is impulse noise also known as salt & pepper. Salt and pepper noise not only corrupts true information of the image, but also seriously affects the visual effects of the image. Therefore, the reduction of impulse noises has important significance to image processing and computer vision analysis. In this type of noise, a pixel gets the minimum or maximum value that can take in a dynamic range of available values.

A large number of algorithms have been proposed to remove this noise while still trying to preserve image details. For an image corrupted by noises, we can use linear or nonlinear filter methods to reduce noises. In the case of linear filtering, the noise reduction algorithm is applied for all pixels of the image linearly without knowing about noisy pixel and non-noisy pixel.

II. LITERATURE REVIEW

In the field of digital image processing filter plays an important role in the image de-noising process. It is a technique for modifying or enhancing an image. There are different papers in which many methods have been proposed by using multiple images by different authors are as follows.

One of the important implementation of Median Filtered Image Quality Enhancement and Anti-Forensics via Variational Deconvolution by Wei Fan, Kai Wang, Franc¸ois Cayre, and Zhang Xiong [1] have been proposed an image variational deconvolution framework for both quality enhancement and antiforensics of median filtered images. This method can serve as a median filtered image quality enhancement technique, whose efficacy is validated by experiments conducted on median filtered images which have been previously “salt & pepper” noised. The proposed method outperforms the state-of-the-art median filtering anti-forensics, with a better forensic undetectability against existing detectors as well as a higher visual quality of the processed image.

[2] Comparative Analysis of Median Filter and Adaptive Filter for Impulse Noise. The basic idea behind this analysis is the maximization of the similarities between

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pixels in a predefined filtering window. The comparison introduced to this median filter and adaptive filter lies in the establishment of parameters of the similarity function. The results show that the adaptive filter outperforms most of the basic algorithms for the reduction of impulsive noise in grey scale images.
Denoising of salt-and-pepper noise corrupted image using modified directional-weighted-median filter by Ching-Ta Lu, Tzu-Chun Chou [3] have been proposed many denoising algorithms to recover a noise corrupted image. The experimental results show that the proposed approach cannot only efficiently suppress high-density impulse noise, but also can well preserve the detailed information of an image.
An Improved Median Filtering Algorithm for Image Noise Reduction The algorithm uses the correlation of the image to process the features of the filtering mask over the image [4]. It can adaptively resize the mask according to noise levels of the mask. The statistical histogram is also introduced in the searching process of the median value. Experimental results show that the algorithm reduces the noise and retains the details of the image. The complexity of the algorithm is decreased to O (N), and the performance of noise reduction has effectively improved.
Another important implementation of Prof.R.Gayathri1, Dr.R.S.Sabeenian [5] have been presented A Survey on Image Denoising Algorithms (IDA), In which Several denoising procedures are proposed to preserve the image quality in textured images by removing the noiseencountered .In this paper the effective noise removal techniques are discussed for various types of images and thesuggestions for improving the interpretability or the perception of information in the image are listed.
A New Adaptive Weight Algorithm for Salt and Pepper Noise Removal [6] developed A new adaptive weight algorithm for theremoval of salt and pepper noise. It consists of two major steps,first to detect noise pixels according to the correlations betweenimage pixels, then use different methods based on the variousnoise levels. Experimentsshow the proposed algorithm has advantages over regularizingmethods in terms of both edge preservation and noise removal, even for heavily contaminated image with noise level as high as 90%, it still can get a significant performance.

III.PROPOSED WORK

Digital image quality improvement is a field of engineering that studies methods to recover an original scene from degraded observations. Often, the captured image may not be of good quality because of factors such as noise, poor brightness, contrast, blur, or artefacts. Figure shows the block diagram for image quality improvement using different filtering algorithms.

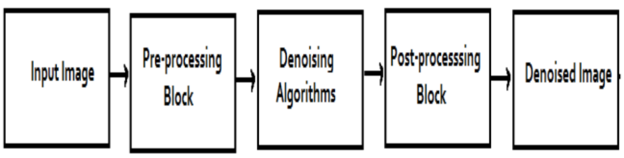

Fig 1: Block diagram of proposed work

The basic block diagram of analysis of image quality improvement consists of three major stages: Pre-processing, Denoising Algorithms, Post processing block.

A. Input Image
In the Digital Image Processing field, removing the noise from the image is the difficult issue. An image is unfortunately corrupted by various factors. The distortions of images by noise are common during its processing and transmission. These noisy effects decrease the performance of visual analysis. Gaussian noise (White noise), Salt & Pepper noise and Speckle noise are the types of noises which are generally found in Images, and also denoising them with the help of some efficient technique is of main task. Noise when get added to image destroy the details of it. So in order to preserve the real image, noise should get removed from it. And for the purpose of enhancement the contrast of the image should be improved.

B. Pre-processing block
In this block different processes are done on the input image such as first convert the 3D visual information into 2D digital form. After that improve the image quality by enhancement, restoration and using different denoise filtering techniques. Several techniques have been proposed over the years for image filtering. Linear filtering techniques have been the methods of choice for many years for their mathematical simplicity and existence theory for their design and implementation nonlinear approaches have been found to be more effective for this purpose. Filters having good edge and image detail preservation properties are highly suitable for image filtering and enhancement. New algorithms and techniques, which can take advantage of the increase in computing power and can handle more realistic assumptions, are needed. Thus, the development of nonlinear filtering techniques such as median filter, adaptive median filter, decision based adaptive median filter, and our proposed method i.e. modified unsymmetric trimmed median filter which perform equally well under wide variety of applications, is of great importance.

C. Denoising Algorithms

1. Mean filter algorithm
The mean filter is a simple spatial filter .It is a sliding-window filter that replaces the centre value in the window. It replaces with the average mean of all the pixel values in the kernel or window. The window is usually square but it can be of any shape.

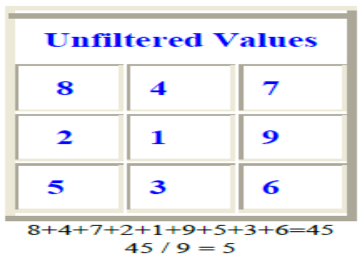

Fig 2: An Example of mean filter

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Mean filtered		
*	*	*
*	5	*
*	*	*

Fig 3: In this Centre value which is previously 1 in the unfiltered value is replaced by the mean of all nine values that is 5.

2. Median Filter
In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.The median filter with good denoising power, simple implementation, and high computational efficiency exploits the rank-order information of pixel intensities within a filtering window and replaces the centre pixel with the median. However, when the median filter is used to restore the corrupted images, both noise-pixels and noise-free pixels are modified, this results in the elimination of fine details such as thin and corner, blurring, or distortion in the image. To avoid the damage of noise-free pixels, some solutions have been proposed to trade off detail preservation against noise reduction. It reduces noise having noise density upto 10-20%.

Algorithm:
Following are some steps to implement median filter algorithm-
Step 1: Check Each and every pixel of the image for the presence of salt and pepper noise. If it falls between 1 and 254, inclusively, it remains unchanged. Otherwise, the pixels with intensity value of 0 or 255 drop.

$$\begin{bmatrix} \text{a11 a12 a13} & \cdots & \vdots \\ \text{a21 a22 a23} & \ddots & \vdots \\ \vdots & \cdots & \vdots \end{bmatrix}$$

256x256
Step 2: Select 2D 3x3 window. Let Pxy be the processing pixel which lies at the centre of the window.

$$\begin{bmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{bmatrix}$$

3x3
Step 3: Convert 2D image into 1D (in single row) which contain 9 elements.
$[a11\ a12\ a13\ a21\ a22\ a23\ a31\ a32\ a33]_{1x1}$
Step 4: Arrange all single row element into ascending order.
Step 5: Take median of single row element.
i. If no of observations(n) is odd then
Median= $\left(\frac{n+1}{2}\right)^{th}$ term of the observation
ii. If 'n' is even number then
Median= mean of term $\left(\frac{n}{2}\right)$thand term $\left(\frac{n+2}{2}\right)$th of the given observation
Step 6: Replace processing pixel by median value.
Step 7: Repeat same process for all noisy and noise free pixel.

2. adaptive median filter
The Adaptive Median Filter is another type of non-linear median filter which performs well if the noise density of the salt and pepper noise is not large. This filter identifies possible noisy pixels and replaces them using the median filters while leaving all other pixels unchanged. The size of the window applied to filter the image pixels is adaptive in nature, i.e. the window size is increased if the specified condition does not meet. If the condition is met, the pixel is filtered using the median of the window. It reduces noise having noise density upto 20-30%. Following steps describes the steps of Adaptive filter algorithm-

Adaptive Filter Algorithm:
Step 1: Check Each and every pixel of the image for the presence of salt and pepper noise. If it falls between 1 and 254, inclusively, it remains unchanged. Otherwise, the pixels with intensity value of 0 or 255 drop.

$$\begin{bmatrix} \text{a11 a12 a13} & \cdots & \vdots \\ \text{a21 a22 a23} & \ddots & \vdots \\ \vdots & \cdots & \vdots \end{bmatrix}$$

256x256
Step 2: Select 2D 3x3 window. Let Pxy be the processing pixel which lies at the centre of the window.

$$\begin{bmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{bmatrix}$$

3x3
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Step 4: Arrange all single row element into ascending order.
Step 5: Take median of single row element.
i. If no of observations(n) is odd then
Median= $\left(\frac{n+1}{2}\right)^{th}$ term of the observation
ii. If 'n' is even number then
Median= mean of term $\left(\frac{n}{2}\right)$thand term $\left(\frac{n+2}{2}\right)$th of the given observation
Step 6: Replace processing pixel by median value.
Step 7: Repeat same process by increasing the window size if the specified condition does not meet (means use 5x5, 7x7, 9x9,…etc.). If the condition is met, the pixel is filtered using the median of the window.
Step 8: Repeat same process for all noisy and noise free pixel.

4. Decision based Adaptive Median Filter
The Decision Based Algorithm (DBA) processes only the noisy pixel by identifying them by their intensity values. Generally the salt and pepper noise introduces pixels with

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intensities either minimum or maximum (0-255, 8-bit image). The noisy pixel is replaced by the median/mean/mid-point value of the window or by its neighbourhood values. For high density salt and pepper noise it might so happen that the replaced pixel (median/mean) might be a noisy pixel which does not help in suppression of noise. It reduces noise having noise density is 30-40%.

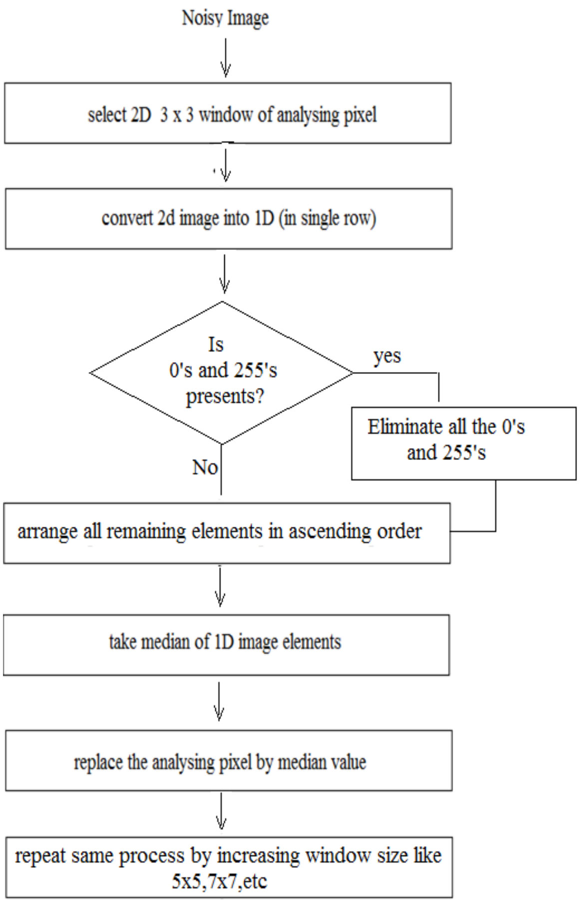

Fig 4.strucure of Decision Based Adaptive Median filter

Proposed Algorithm

5. Modified decision based Unsymmetric Median Filter

Our proposed filter method the Modified Decision Based Unsymmetric Trimmed Median Filter replaces the noisy pixel by the trimmed median value (excluding the minimum and maximum intensities in the window)when other pixel values, 0's and 255's are present in the window. It removes noise having noise density is 70-90%.

Algorithm

Step 1: Select 2-D window of size 3 3. Assume that the pixel being processed is .

Step 2: If then is an uncorrupted pixel and its value is left unchanged.

Step 3: If or then is a corrupted pixel then two cases are possible as given in Case i) and ii).

Case i): If the selected window contains all the elements as 0's and 255's. Then replace with the mean of the element of window.

Case ii): If the selected window contains not all elements as 0's and 255's. Then eliminate 255's and 0's and find the median value of the remaining elements. Replace withthe median value.

Step 4: Repeat steps 1 to 3 until all the pixels in the entire image are processed.

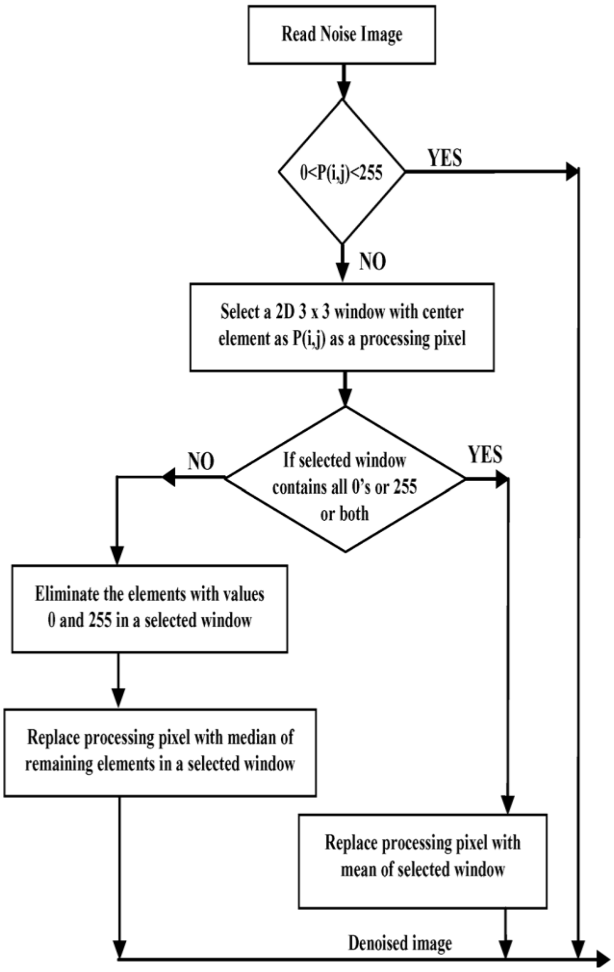

Fig 5. Structure of modified Decision Based Unsymmetric Trimmed Median filter

D. Post Processing Block:

Most of the previously known techniques are applicable for the denoising of images corrupted with less noise density. Here a new decision based technique has been presented which shows better performances than those already being used and the new proposed algorithm will definitely protect the image from noise and distortion.In this paper we have analysed different denoise filtering techniques for image quality improvement and this concept is applied to the different images and they are compared with one another. The comparison between denoised images is taken in terms of performance parameters such as mean square error (MSE), Image Enhancement Factor (IEF), peak signal to noise ratio (PSNR), correlation, etc.

E. Denoised Image

By using different filtering techniques we will get improved quality of image .depending on the noise density we will apply different algorithms to image and analysed the parameters of the denoised image.

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IV. EXPERIMENTAL RESULT

The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image compression quality

- **Mean Square Error (MSE):**

The MSE is the cumulative square error between the encoded and the original image defined by:

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where, I_1 is the original image and I_2 is the uncompressed image. The dimension of the images is m x n. Thus MSE should be as low as possible for effective compression.

- **Peak Signal to Noise Ratio (PSNR):**

PSNR represents a measure of the peak error. The higher the value of PSNR, the lower the error.
To compute the PSNR, the block first calculates the mean squared error using the following equation

$$PSNR = 10 \log_{10}\left(\frac{R^2}{MSE}\right)$$

- **Image Enhancement Factor (IEF):**

The IEF defined as given below-

$$IEF = \left(\sum_{m,n} (P(m,n) - O(m,n))^2\right) \Big/ \left(\sum_{m,n} (R(m,n) - O(m,n))^2\right)$$

Where, P is corrupted image,
O is original image and
R is restored image or denoised image.

TABLE I COMPARISION OF MSE VALUES OF DIFFERENT ALGORITHM FOR CAMERAMAN IMAGE AT DIFERENT DENSITIES

Performance parameter:		MSE			
Noise density		10%	30%	50%	70%
Filters -	1. Mean	1.7669e+04	1.7672e+04	1.7676e+04	1.7680e+04
	2. Median	84.9932	457.322	2.3431e+03	7.2156e+03
	3. AMF	28.1258	79.3024	246.9526	1.8612e+03
	4. DBAMF	16.7765	73.4980	183.8505	435.2204
	5. MDBUTMF	9.0325	42.8134	103.4843	397.8231

TABLE II COMPARISION OF PSNR VALUES OF DIFFERENT ALGORITHM FOR CAMERAMAN IMAGE AT DIFERENT DENSITIES

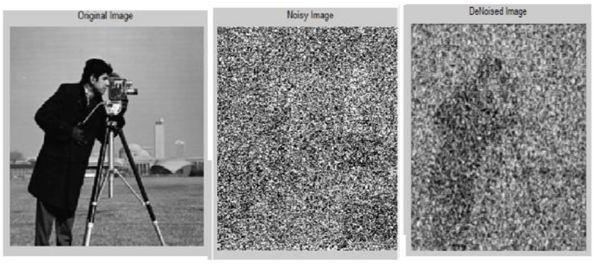
		PSNR			
Noise density		10%	30%	50%	70%
Filters -	1. Mean	5.6587	5.6579	5.6570	5.6560
	2. Median	28.8370	21.5286	14.4329	9.5480
	3. AMF	33.6398	29.1379	24.2047	15.4329
	4. DBAMF	35.8838	29.4680	25.4862	21.7437
	5. MDBUTMF	38.5727	31.8150	27.9821	22.1339

TABLE III COMPARISION OF IEF VALUES OF DIFFERENT ALGORITHM FOR CAMERAMAN IMAGE AT DIFERENT DENSITIES

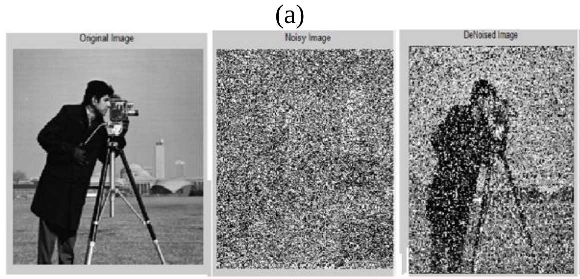
		IEF			
Noise density		10%	30%	50%	70%
Filters -	1. Mean	0.9999	0.9999	0.9999	0.9999
	2. Median	23.1657	13.2408	4.3085	1.9479
	3. AMF	69.7944	75.306	40.6222	7.5564
	4. DBAMF	122.9581	82.3013	54.7402	32.7815
	5. MDBUTMF	205.9639	142.8514	95.9503	35.3156

TABLE IV COMPARISION OF CORRELATION VALUES OF DIFFERENT ALGORITHM FOR CAMERAMAN IMAGE AT DIFERENT DENSITIES

		CORRELATION			
Noise density		10%	30%	50%	70%
Filters -	1. Mean	0.9486	0.8439	0.6680	0.4260
	2. Median	0.9888	0.9410	0.7431	0.4246
	3. AMF	0.9963	0.9896	0.9676	0.7890
	4. DBAMF	0.9978	0.9903	0.9758	0.9430
	5. MDBUTMF	0.9988	0.9944	0.9863	0.9470



(a)



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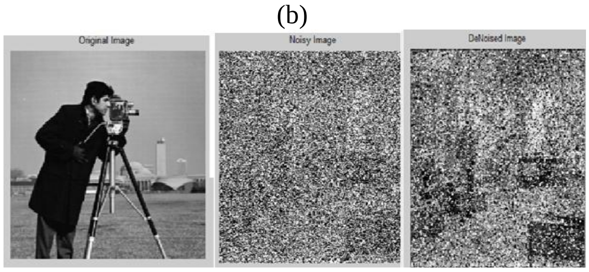

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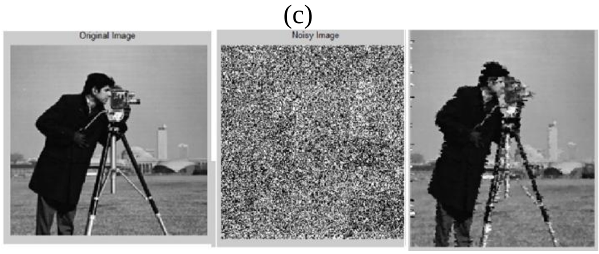

(d)

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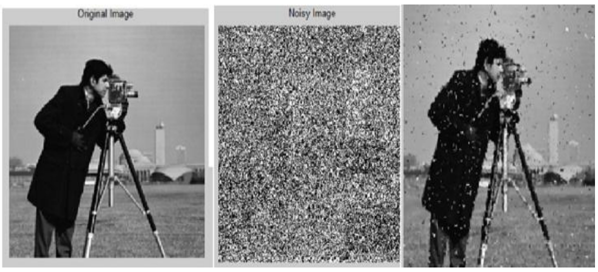
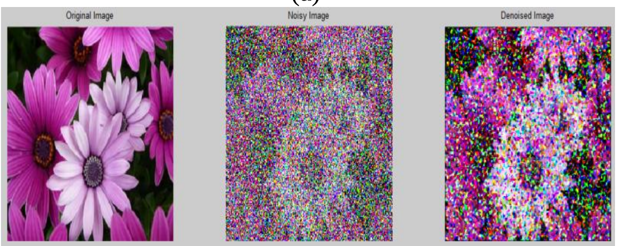


(e)

Fig 5.Results of different algorithms for cameraman image.(a) Output of mean filter (b) Output of MF. (c) Output of AMF. (d) Output of DBAMF.(e)Output of MDBUTMF. for 70% noise density respectively.

(a)



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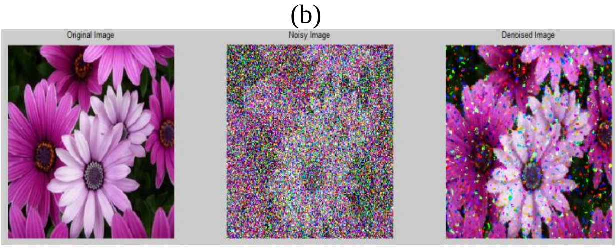
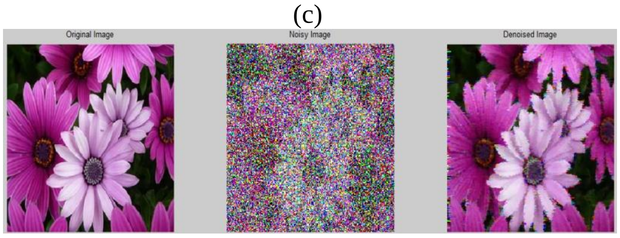
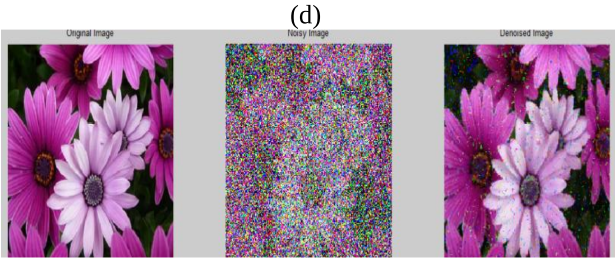


(c)



(d)



(e)

Fig 6.Results of different algorithms for color image.(a) Output of mean filter (b) Output of MF. (c) Output of AMF. (d) Output of DBAMF.(e)Output of MDBUTMF. for 70% noise density respectively.

V. CONCLSION

Filters are used best for removing noise from the images. In this paper, a new algorithm has been proposed that increases the efficiency of the removal of salt and pepper noise. Results of this algorithm exhibit better performance in comparison with MF, AMF, DBA and MDBA in terms of higher MSE, PSNR, IEF and correlation. The proposed filter also shows consistent and stable performance for noise densities varying from 10%-90%. The proposed filter shows better image enhancement factor for salt and pepper noise of density more than 70%. As a future work the proposed algorithm can be further improved by implementation of de-blurring techniques in neural networks or fuzzy logic outputs and also to remove other types of noisesuch as speckle noise, random noise, Rayleigh noise, Gaussian noise, etc.

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