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Removable of Noise on MRI (Digital) Images by Using MDUTMF

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Abstract:

Medical imaging and bio-medical have special place for the image processing field in modern science. With the advent of developing imaging modalities like magnetic resonance imaging, computerized tomography (CT), mammography, and ultra sonography (USG) it is now possible to look inside the internal structure of sick body. It provides a convenient way to diagnose, monitor and track the abnormality in the ailing body. In this paper results and effects of various filter technique applied to tumor-bearing MRI images of brain have been presented. Performance of various image enhancement/noise removal techniques is evaluated using Peak Signal to Noise Ratio (PSNR) for MRI images as aimed at identifying tumor is given.

Keywords:

Magnetic resonance images, image enhancement, noise removal.

I.INTRODUCTION:

The impact of digital image processing is increasing by the day for its use in the medical and research areas. For example, Magnetic Resonance Imaging (MRI) has become a widely used method of high quality medical imaging, especially brain imaging where MRIs soft tissue contrast and non-invasiveness is a clear advantage. MRI provides a matchless view inside the human body. The level of details that we can see is extraordinary on being compared with any other imaging modality. Proper, reliable and fast detection of brain cancer is of major technical and economic importance for the doctors [4]. No accurate detection of tumor region due to the presence of noise in MR image. Even small amount of noise can change the classification. Gray matter is made up of neuronal cell bodies.

The Gray matter includes regions of the brain involved in muscle control, sensory perception such as seeing and hearing, memory, emotions, and speech. White matter is one of the two components of the central nervous system and consists mostly of glial cells and myelinated axons that transmit signals from one region of the cerebrum to another and between the cerebrum and lower brain centers. Noisy image can cause misclassifications of Gray Matter (GM) as White Matter (WM). So the noise is preprocessed using denoising technique. Resolution of an image is always an issue in medical image processing which means loss of quality at the image edges. Resolution enhancement is used to preserve the edges and contour information. The major application of these techniques is detection of tumor cells in human body [1, 2].The aim of denoising technique is removal of noises from an image and thus becomes the first step in image processing. The technology for removal of noise should be applied carefully; otherwise noise removal introduces artifacts which cause blurring of the image [3].In this paper, we provide a quantitative evaluation of the performance of different de-noising techniques for MRI images. In particular, we benchmark various image enhancement techniques, namely the median filter, Mean filter, wiener filter and Modified decision based unsymmetric median filter (MDUTMF)

II.EXISTING METHOD :

1. Denoising Mechanism:

Most of the imaging techniques are degraded by noise so that the image is preprocessed using denoising technique to extract the useful information. To analyze the medical image i.e. Segmenting the brain tissues, initially the noise must be removed from the MRI image for retaining the original information. Noise in medical imaging is mainly caused by variation in the detector sensitivity, reduced object visibility (low contrast), chemical or photographic limitations, and random fluctuations in radiation signal.

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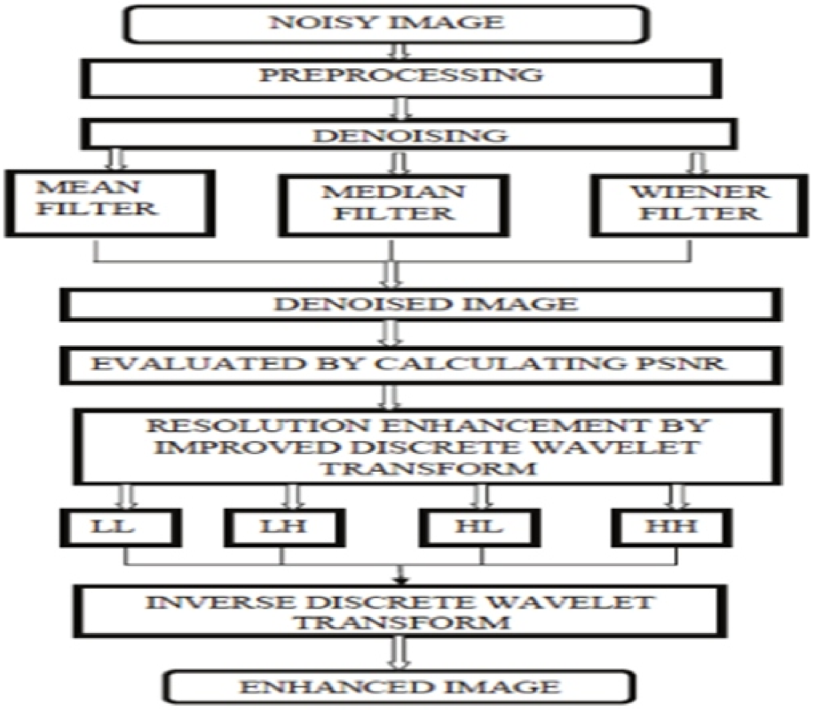

Fig 1: Overview of the Existing work

Initially the MRI image is taken as an input data. The MRI image is added with Salt and pepper noise. The denoising is performed using averaging filter, median filter, wiener filter and Modified decision based unsymmetric median filter (MDUTMF). The performance of these denoising techniques is measured using Peak Signal to Noise Ratio. Overview of the proposed work

A. Salt and Pepper Noise:

Salt & Pepper Noise in the images is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. For images corrupted by salt-and-pepper noise, noisy pixels can take only the maximum or the minimum values. There are many works on the restoration of images corrupted by salt & pepper noise. The median filter was once the most popular nonlinear filter for removing salt & pepper noise because of its good denoising power and computational efficiency. However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter. Different remedies of the median filter have been proposed, e.g., Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) [5]. The proposed Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) algorithm processes the corrupted image pixel by pixel.

If the processing pixel value is 0 or 255, it is processed or else it is left unchanged. Since no changes are made to the non-noisy pixels and window size is changed dynamically depending on the noise density, the performance of our combined approach is much better than that of either one of the methods. Salt and pepper noise with noise density as high as 90% can be cleaned quite efficiently.

B. Averaging Filter:

Mean filter is the optimal filter for removing grain noise in an image. It is a linear filter that applies mask over each pixel in the signal. Each of the components of the pixels coming under the mask are averaged together to form a single pixel that is why the filter is otherwise known as average filter [6, 7]. Here first take an average that is sum of the elements and divide the sum by the number of elements. Next, replace each pixel in an image by the average of pixels in a square window surrounding this pixel.

$$h[i,j] = \frac{1}{9}\sum_{k=i-1}^{i+1}\sum_{j=i-1}^{i+1} f(k.l) \quad \text{.....................} (1)$$

Where M is the total number of pixels in the neighborhood N and k, l =1, 2... For example, a 3*3 neighborhood about [i, j] yields:

$$h[i,j] = \frac{1}{9}\sum_{k=i-1}^{i+1}\sum_{j=i-1}^{i+1} f(k.l) \quad \text{.................. (2)}$$

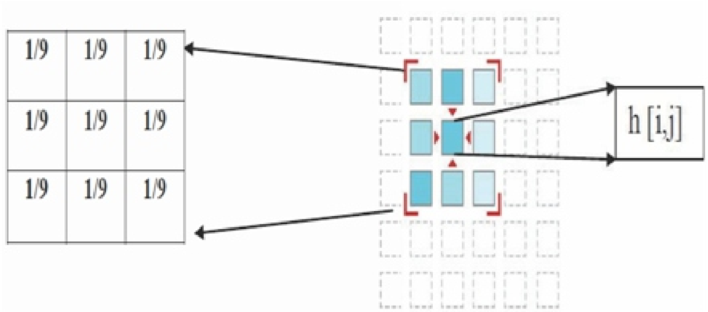

Fig 2: Functionality behind the averaging filter

Problem with averaging of filter is that it can remove noise more effectively in larger windows, but also blur the details in an image an image.

C. Median Filter:

Median filtering is a nonlinear process useful in reducing impulsive or salt-and-pepper noise. It is also useful in preserving edges in an image while reducing random noise. Impulsive or salt-and pepper noise can occur due to a random bit error in a communication channel. In a median filter, a window slides along the image, and the median intensity value of the pixels within the window becomes the output intensity of the pixel being processed. The median filter is normally used to reduce noise in an image, somewhat like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image.

The median is calculated by sorting all the pixel values from the surrounding neighborhood into numerical order and then replacing the pixel being considered with the middle pixel value [8]. Note that if the window has an odd number of entries, then the median is simple to define. It is the middle value after all the entries in the window are sorted numerically.

For an even number of entries, there is more than one possible median. In median filtering, the neighboring pixels are ranked according to brightness (intensity) and the median value becomes the new value for the central pixel.

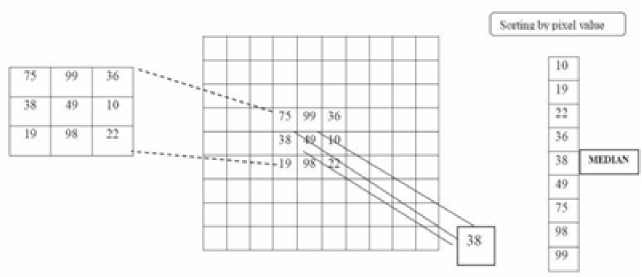

Fig 3: shows the working principle of median filter.

Advantages of median filter are there is no reduction in contrast across steps, since output values available consist only of those present in the neighborhood (no averages). The median is less sensitive than the mean to extreme values (outliers), those extreme values are more effectively removed. The disadvantage of median filter is sometimes this is not subjectively good at dealing with large amount of Gaussian noise as the mean filter.

D. Wiener Filter:

In signal processing, the Wiener filter is a filter used to produce an estimate of a desired or target random process by linear time-invariant filtering an observed noisy process, assuming known stationary signal and noise spectra, and additive noise. The Wiener filter minimizes the mean square error between the estimated random process and the desired process. The most important technique for removal of blur in images due to linear motion or unfocussed optics is the Wiener filter. From a signal processing standpoint, blurring due to linear motion in a photograph is the result of poor sampling [9, 10]. Each pixel in a digital representation of the photograph should represent the intensity of a single stationary point in front of the camera.

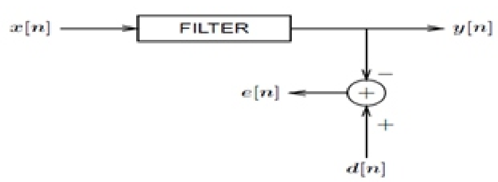

Fig 4: shows the working principle of Wiener filter.

Q: Is there an obvious solution for this case?

A: Sure, pick H (z) = z, but this is worthless for this real-time example!

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In order to talk about an "optimal" filter which estimates d[n] from x[n], we must have a method of measuring how good a job the filter does. A "cost function" is used to judge the performance, and could take on many different forms.

For example,

We most commonly use the mean square error (MSE) as our cost function.

$$\xi = E[e^2[n]] \quad \text{..................(3)}$$

Where E [.] represents statistical expectation, and

$$E[e^2[n]] = \int_{-\infty}^{\infty} x^2 p_e(x)\, dx \quad \text{................(4)}$$

Where pe (x) is the probability density function of the error. The filter that is optimum in the MSE sense is called a Wiener filter.

In all our analyses here we will assume:
1. X[n] is wide-sense stationary, i.e. it has constant (and finite) mean and variance, and a correlation Function.
2. All of the signals are zero-mean.
3. We use MSE as our error criterion.
2. Resolution Enhancement:

Resolution of an image is always an issue in medical image processing. Resolution is a measure of the amount of detail information in the image. High resolution gives more image details. Initially the image is preprocessed using denoising. After denoising it results in noise reduction and loss of quality at the image edges.

Resolution enhancement is used to preserve the edges and contour information of a filtered image. In order to segment an image accurately preserving the edges and contour information is important. Resolution is the measurement of quality of a denoised image. In order to enhance the resolution of an image an improved discrete wavelet transform is proposed. The improved DWT preserves the edges and the contour information. The performance of resolution enhancement technique is measured using Peak Signal to Noise Ratio.

A. Discrete Wavelet Transform:

Wavelet transforms are used in a wide range of image processing applications such as image and video compression, feature detection and recognition, and image denoising. The 2-D wavelet decomposition of an image is performed by applying the 1-D discrete wavelet transform (DWT) along the rows of the image first, and then the results are decomposed along the columns [11, 12, and 13]. One level DWT (with Daubechies 9/7 as wavelet function) is used to decompose an input image into different sub-band images. Three high frequency subbands (LH, HL, and HH) contain the high frequency components of the input image. The sub-band images are referred to low-low (LL), low-high (LH), high-low (HL) and high-high (HH). The frequency components of those four sub-bands are interpolated to cover the full frequency spectrum of the original image. The interpolation technique is used to increase the number of pixels in an image. The high frequency sub-band of the image is interpolated to low frequency sub-bands of the image to give high resolution enhanced image.

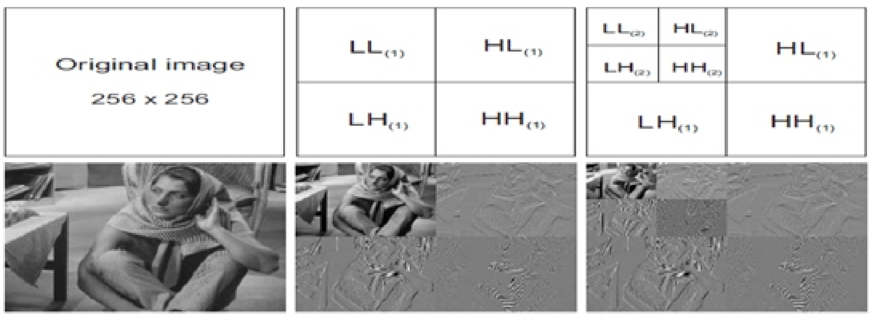

Fig 5: DWT processing generating two and three levels of resolution.

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The low resolution image (LL sub-band), without quantization (i.e., with double-precision pixel values) is used as the input for the proposed resolution enhancement process. In other words, low frequency sub-band images are the low resolution of the original image. Therefore, instead of using low-frequency sub-band images, which contains less information than the original input image, the input image is used through the decimation process [14]. Hence, the input low-resolution image is decomposed with the half of the decimation factor to improve DWT.

B. Inverse Discrete Wavelet Transform:

A process by which components can be assembled back into the original image without loss of information is called reconstruction. Inverse Discrete Wavelet Transform (IDWT) reconstructs an image from the approximation and detail coefficients derived from decomposition. The performance of denoised and enhanced image is evaluated by calculating PSNR value.

III.PROPOSED ALGORITHM :

The proposed Modified Decision Based Unsymmetrical Trimmed Adaptive Median Filter (MDBUTAMF) algorithm processes the corrupted images by first detecting the salt and pepper noise. The processing pixel is checked whether it is noisy or noise free. If the processing pixel lies between maximum and minimum gray level values, then it is noise-free pixel and it is left unchanged. If the processing pixel takes the maximum or minimum gray level, then it is noisy pixel which is processed by MDBUTAMF [15, 16]. While processing image, always noisy image is taken as reference for calculation of mean or median and processing pixel is replaced by mean or median in output image.This is explained as follows. Let ‘a’ be the input noisy image and ‘b’ be the output image which initially is a copy of the input noisy image ‘a’.

Now the image ‘a’ acts as the reference image and it is processed pixel-by-pixel and the corresponding pixel in the image ‘b’ is replaced with the output pixel which is obtained as a result of processing done on image ‘a’. The steps of the MDBUTMF are explained as followsAn advanced non linear cascading filter algorithm for the removal of high density salt and pepper noise from the digital image is processed the processed method consists of two stages.

The first stage decision based median filter (DMF) acts as the preliminary noise removal algorithm. Second stage is MDUTMF which is used to remove the remaining noise and enhance the image quality.

Algorithm:

Step 1: Read Noisy Image.
Step 2: Select 2D window of size 3x3 with centre element as processing pixel. Assume that the pixel being processed is Pij.
Step 3: If Pij is an uncorrupted pixel (that is, 0< Pij<255), then its value is left unchanged.
Step 4: If Pij = 0 or Pij = 255, then Pij is a corrupted pixel.
Step 5: If 3/4th or more pixels in selected window are noisy then increase window size to 5x5.
Step 6: If all the elements in the selected window are 0s and 255s, then replace Pij with the mean of the elements in the window else go to step 6.
Step 7: Eliminate 0s and 255s from the selected window and find the median value of the remaining elements. Replace Pij with the median value.
Step 8: Repeat steps 2 to 6 until all the pixels in the entire image are processed.

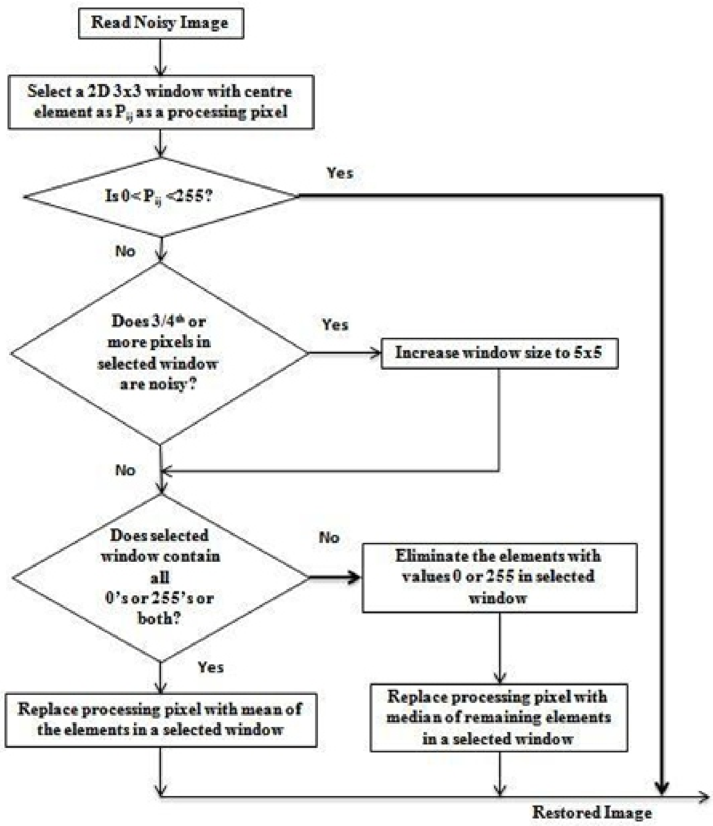

Fig 6: flow chart of the proposed algorithm

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IV.QUALITY ANALYSIS:

The quality of the preprocessed images is analyzed using Peak Signal to Noise Ratio (PSNR). It is defined as the ratio between the maximum possible power of an image and the power of corrupting noise measure of the peak error. To compute the PSNR, first, calculate the mean-squared error. Mean Square Error (MSE) is the cumulative squared error between the denoised and the original image.

$$MSE = \frac{\Sigma_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M*N} \quad ....(5)$$

Where I1 (m, n) denotes original image, I2 (m, n) denotes denoised image and M and N are the number of rows and columns in the input images Then it can be very easy to compute PSNR using the following equation:

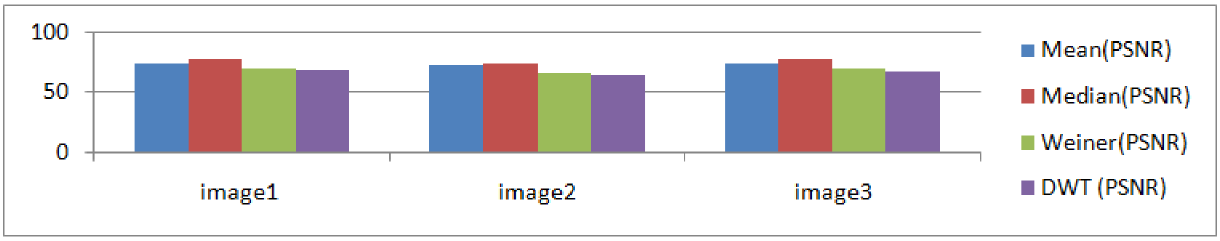
$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right) \quad ....(6)$$

Where, R is the maximum fluctuation in the input image data type. For example, if the input image has a double-precision floating-point data type, then R is 1. If it has an 8-bit unsigned integer data type, R is 255, etc. Logically, if the PSNR is higher it gives the better quality of the reconstructed image

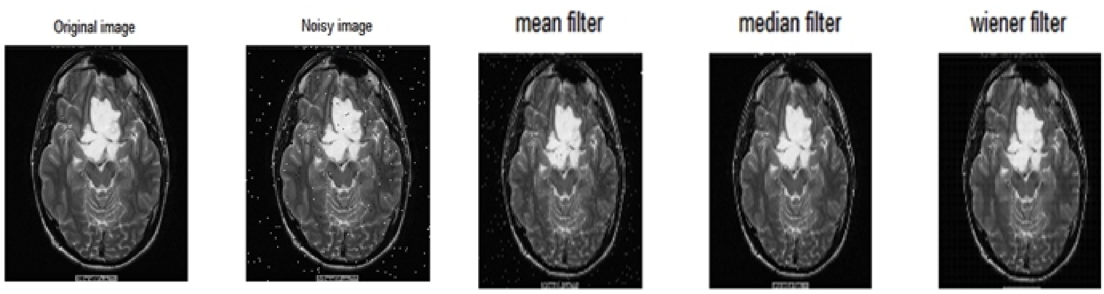
Existing method simulation results:

Analysis	Mean filter	Median filter	Weiner filter	DWT
Image1 (PSNR)	73.7766	78.0684	70.7970	68.6576
Image2	73.4587	74.9319	66.5767	64.2607
Image3	73.7367	77.8661	70.3250	68.0056

(a)



(b)



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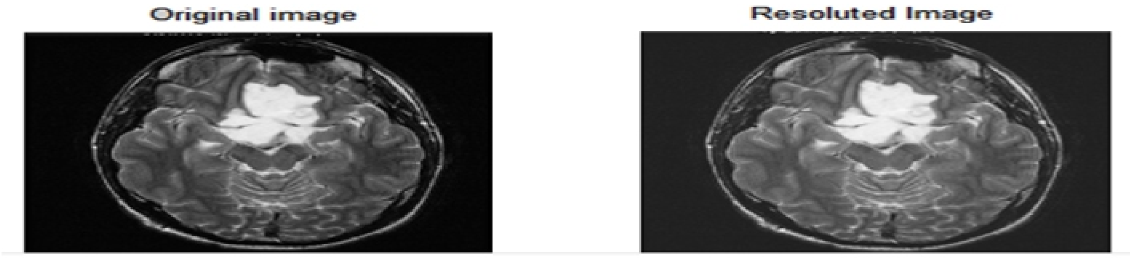


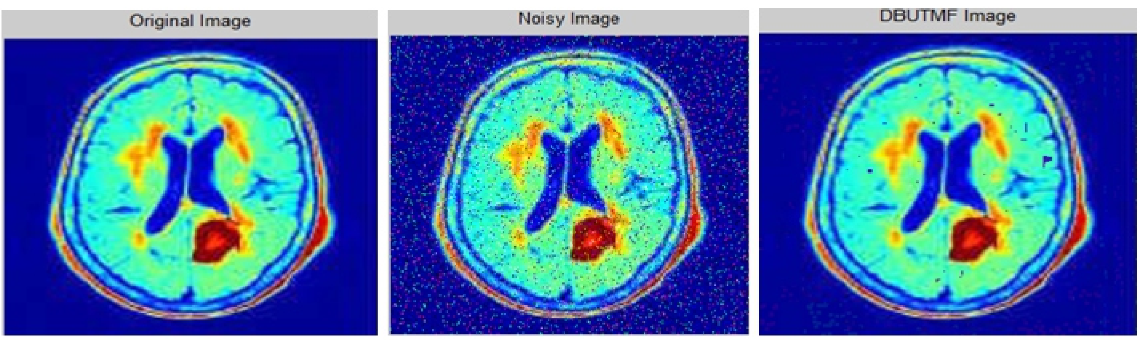
(c)

Fig 7: a). PSNR values of denoised and enhanced image
b). Performance of the denoised image c).Denoised and enhanced images

Proposed method simulation results:

Parameters/Noise	Salt and Pepper	Speckle	Gaussian
PSNR	40.1509	26.5384	24.6607
MSE	11.0969	171.003	222.392

(a)



(b)

Fig 8: a).Performance of MDUTMF on different noises b).Denoised and enhanced image

V.CONCLUSION:

In this letter, a new algorithm (MDBUTMF) is proposed which gives better performance in comparison with Average filter, Median filter and Wiener filter in terms of PSNR. The performance of the algorithm has been tested at low, medium and high noise densities on both gray-scale and color images. Even at high noise density levels the MDBUTMF gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated. The proposed algorithm is effective for salt and pepper noise removal in images at high noise densities.

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