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PERFORMANCE ANALYSIS OF VARIOUS SCHIZOPRENIA IMAGES AND DE-NOISING THE BRAIN IMAGE USING FILTERS

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ABSTRACT

The primary motivation behind image processing is to change over an image into significant information. Image Enhancement is the most important step that must be carried out in all image handling applications. A few images are inclined to noises from different sources, for example slip in camera adjustment etc. This paper imparts the identification of filter techniques strategies utilizing distinctive sorts of brain images. This paper is based on the identification analysis on the output of noisy and filtered images. This technique is acquiring the noisy images is built on the four types of images: Salt-and-pepper, Gaussian noise, Speckle Noise and Poisson Noise induced in a peripheral brain image and there are removed using four types of spatial filters: Mean Filter, Median Filter, Gaussian filter and Wiener Filter, in order to critic the efficiency of various filters over different kind of noise. An algorithm is created which execute all the sorts of filtering technique on the input image and arithmetic parameters are computed according to the correlation between output and input images. These arithmetic parameters are exhibit distinctly and they are compared for both the noisy and filtered images. For the calculation of the performance of filters the mathematical parameters are required such as Mean Square Error (MSE), Normalized Absolute Error (NAE) and Normalized correlation (NK), Peak Signal to Noise Ratio (PSNR) are used and the MATLAB codes required in calculating these parameters are developed and it has been shown that Weiner filter is an optimum filter for noisy images.

KEYWORDS: Noise, Errors, De-noising, Enhancement

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I. INTRODUCTION

The development of life is maintained by brain, the brain is an organ that serves as the focal point of the nervous system. The brain is the most intricate organ in a vertebrate's body. In a typical human, the cerebral cortex (the biggest part) is evaluated to contain 15–33 billion neurons each one joined by neural connections to a few thousand different neurons. These neurons correspond with each other by method for long protoplasmic strands called axons, which convey trains of signal pulse called activity possibilities to isolated parts of the brain or body focusing on particular beneficiary cells. Because of the advancement in technology this customary brain examination is digitalized. For this reason, the brain slides are taken and by combining a high determination advanced camera, images are captured by changing amplification to get greater resolution. For recognizing distinctive sorts of pattern in a human brain, image translation method is utilized on different brain images. The initial phase in image transformation is the image preprocessing. It is carried out to upgrade the nature of the image acquired from different sources such that it fulfills the necessity of further processing. Image De-noising is one of the preprocessing systems that is utilized to eliminate clamor from obtained image. Image clamor is the arbitrary variety of brightness or color data in pictures delivered by the sensor and hardware of a scanner or advanced camera. Image de-noising is furthermore referred to as filter, the system for evaluating the arranged types of noise or undesirable information in a image primarily based upon their properties though keeping the fundamental purposes of the picture protected. Image filtering isn't exclusively adapted to enhance the image quality however furthermore utilized as a preprocessing stage within a few applications and additionally image encryption, pattern recognition. General purpose image filter fails to offer the flexibleness and versatility of un-demonstrated clamor sorts. By analyzing the methods to improve the brain image, this paper survey four types of filtering technique on four sorts of noise which can influence the brain image and evaluating the execution of the filter by utilizing four sorts of image quality measures [6] [8]. The filtering algorithms are implemented on twenty five examples of different noise. The simulation is performed on MATLAB R2011a version. Noise removal is easier in the spatial area as contrasted with the frequency space. As the spatial space clamor evacuation requires less preparing time. In this manner this paper expects to perform clamor evaluation in the spatial area instead of utilization of frequency Fourier transformation. The past exploration work emphasized on expelling clamor from remote sensing image, Binary report image, and submerged image. For segmentation analysis, we are using the comparison of three output images as:
Original image segmentation, filtered output segmentation and noised output segmentation.

II. TYPES OF NOISE

Noise is the major disadvantage that is thought to be associated with undesirable information or undesirable electrical signal in a picture along with the standard isn't attained to strike this filter are utilized to acclimated take away the clamor in a picture. In this paper we have made an endeavor to study the four normal sorts of noises like Gaussian, salt and pepper, Poisson and speckle noise [1]. Noise in image is any corruption in a picture, brought by external disturbance while a picture is continuously sent from one spot to a better place by means of satellite, remote and system link. Clamor represents to undesirable information that deteriorates picture quality. Noise reduction is that the process for eliminating noise from a picture. By that the standard of a picture is furthermore scale back. There are various types of noise in picture process, few noise are listed below.

Types

- ❖ Salt and pepper noise
- ❖ Gaussian noise
- ❖ Speckle noise
- ❖ Poisson noise

➢ In **Salt and pepper noise** (sparse lightweight and dark disturbances), parts inside the image area totally differ in shade or power from their incorporating pixels; the forming trademark is that the value of a noisy pixel bears no significance in the color of enveloping pixels. Ordinarily this type of noise can exclusively have an impact on a little scope of picture pixels. The picture which contains black and white dots it is termed as salt and pepper noise. Salt and pepper noise is additionally called Fat-tail distributive or imprudent commotion or spike clamor as shown below in figure 1.1 and 1.2. Typical sources embody flecks of dirt within the camera.

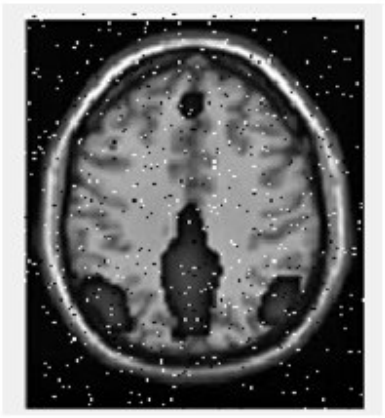

Figure 1.1 : normal brain image with salt and pepper noise

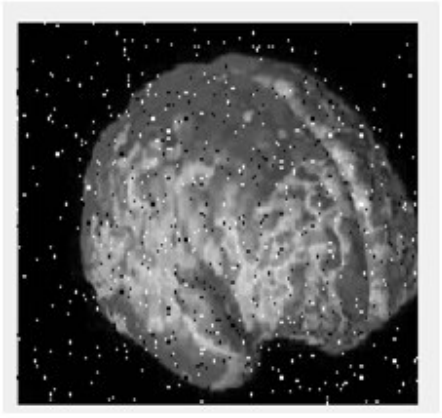

Figure 1.2 : abnormal brain image with salt and pepper noise

➢ In **Gaussian noise,** probability density function (PDF) equivalent to that of the ordinary distribution, which is otherwise known as Gaussian distribution. In other words, the values that the noise can assume are Gaussian-disseminated. It is otherwise called statistical noise. A special case is white Gaussian noise, in which the qualities at any pair of times are identically distributed and statistically independent (and thus uncorrelated). In correspondence filter testing and displaying, Gaussian noise is used as repetitive white noise to produce added substance white Gaussian noise. In information transfers and machine organizing, communication filters can be influenced by wideband Gaussian commotion originating from numerous regular sources, for example, thermal vibrations of atoms in conductors.

Figure 2.1: normal brain image with guassian noise

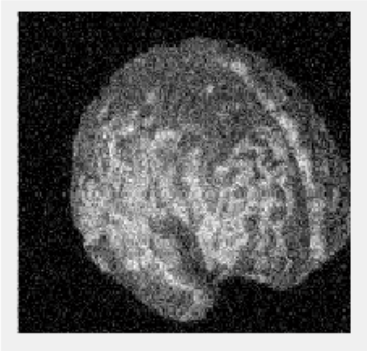

Figure 2.2: abnormal image with guassian noise

The probability density function p of a Gaussian random variable z is given by

$$p_G(z) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(z-\mu)^2}{2\sigma^2}} \quad \rightarrow \quad \textbf{(1)}$$

Where, z represents the grey level,
μ - mean value and
σ - standard deviation.

➢ In Speckle noise, it will be planned by arbitrary qualities expanded by the part estimations of a picture. Spot is a granular "noise" that characteristically exists in and corrupts the nature of the dynamic radar and synthetic aperture radar (SAR) pictures[10]. Speckle noise in customary radar results from irregular changes in the return signal from an object that is no greater than a solitary image processing component. It expands the mean grey level of a neighborhood. Speckle noise in SAR is by and large more genuine, bringing more challenges for picture interpretation. It is caused on by rational preparing of backscattered signs from different dispersed targets. In SAR oceanography, for instance, speckle noise is brought on by signs from elementary disperses, the gravity-capillary ripples, and shows as a platform image, below the picture of the ocean waves as shown below,

Figure 3.1: normal brain image with speckle noise

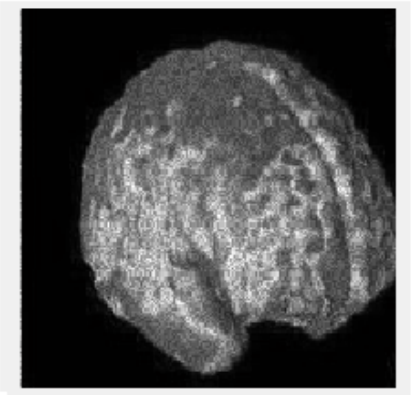

Figure 3.2: abnormal brain image with speckle noise

➢ In Poisson noise, the Poisson distribution is a discrete probability allocation that communicates the probability of a given number of occasions happening in a fixed interval of time and/or space if these occasions happen with a known average rate and freely of the time since the last occasion. The Poisson distribution can likewise be utilized for the quantity of events in other specified intervals, for example distance, area or volume. It is also called shot noise.

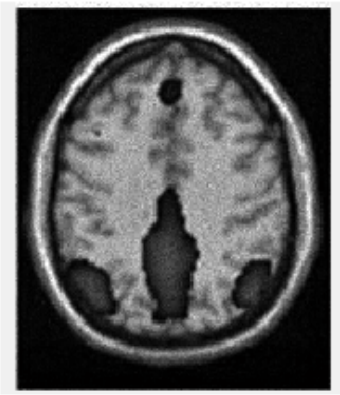

Figure 4.1: normal brain image with poisson noise

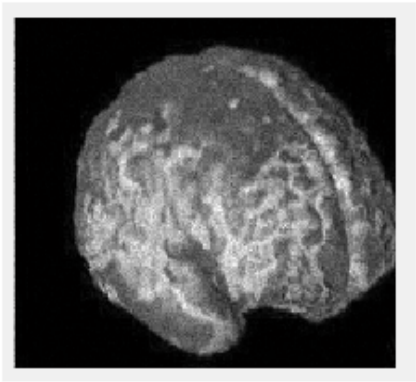

Figure 4.2: abnormal brain image with poisson noise

The signal-to-noise ratio (SNR) is given by

$$\mathrm{SNR} = \frac{N}{\sqrt{N}} = \sqrt{N}. \qquad \rightarrow \textbf{(2)}$$

These are the few forms of noise present in a image, that decreases the standard of a picture in addition because it can corrupt the information that is sent by the image. By understanding the on top of mentioned noise, we will essentially focus on the kind noise that is available inside the picture. Within the noise identification step, area of noise is recognized. Accordingly we have a tendency to filter this sort of noise by some filters.

CAUSE OF IMAGE NOISE

- ❖ Error occur in image signal
- ❖ Sensor heat
- ❖ Size of sensing component

III. IMAGE DE-NOISING TECHIQUES

In image processing, filters are basically used to reduce either the high frequencies in the picture, i.e. smoothing the picture, or the low frequencies, i.e. improving or discovering edges in the picture. Spatial processing is classified into point and mask preparing. Point transformation includes the change of singular pixels freely of different pixels in the picture. These basic operations are regularly used to correct the defects in the image obtaining components, for illustration to repay for under/over uncovered pictures. It is a more excessive operation than basic point transforming, anyhow all the more compelling. The application of a mask to an input picture delivers a yield picture of the same size as the information. A standout amongst the most dominant necessities of noise evaluation algorithm will be that they have to give a agreeable measure of noise evaluation furthermore it preserves the edges. For the

given conditions to be fulfilled there are two sorts of filter with their huge favorable circumstances. The two sorts of filters are the straight and non-direct filters. The linear filters have the responsibility of faster processing yet the hindrance of not safeguarding edges. On the other hand the non-direct filters have the focal point of protecting edges[2][3] and the disservice of slower processing. Subsequently this paper means to perform noise evaluation in the spatial area instead of utilization recurrence Fourier transformation. The term Filtering is defined as modified element intensity values to represent the sure image

Characteristics

- Enhancement: improves distinction
- Smoothing: take away noises
- Template matching: detects better-known patterns.

Noise reduction involves 2 steps one is noise detection and another one is noise replacement. The noise detection is that the opening move, location of noise is known. The noise replacement is that the second step, within which the detected reedy pixels area unit replaced by the calculable values.

NOISE REMOVAL TECHNIQUE

- Mean Filtering
- Median Filtering
- Guassian Filtering
- Wiener Filter

Average Filter

Mean filter, or average filter is windowed filter of linear class, that smoothes signal (image). The filter acts as low-pass one. The basic idea behind filter is for any component of the signal (image) take a average among its neighborhood. The most widely recognized linear smoothing procedure is the mean filter, and it is likely the most commonly used filter among mediators. The mean filter is linear type of filtering technique. This filter is predominantly utilized or connected as a part of covers over every pixel in the picture one after an alternate[3]. The execution of every pixel cover are found the middle value of together to make unique pixel from different pixels, henceforth it is called average filter. Primarily in photographic pictures (i.e. brain photographic images) the grain noise are removed utilizing this mean filter likewise this filter performs the spatial separating. This mean filter otherwise called as convolution filter.

Gaussian Filter

In electronics and signal processing, a Gaussian filter is a filter whose impulse response is a Gaussian function (or an approximation to it). Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay. It is considered the ideal time domain filter, just as the ideal frequency domain filter. These properties are important in areas such as oscilloscopes and digital telecommunication systems. Mathematically, a Gaussian filter modifies the input signal by convolution with a Gaussian function; this transformation is also known as the Weierstrass transform. Gaussian filtering is used to blur images and remove noise. The equation of a Gaussian function in one dimension is

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}} \rightarrow (3)$$

Where, σ- Standard Deviation,

G(x) – Gaussian Function of Distribution Gauss function ever comes equal to zero. It is symmetric function. Gaussian noise is not good or effective to remove the salt and pepper noise. Gaussian filter is also known as linear low pass filter.ie image is smoothed by itself.

Median Filter

In signal processing, it is frequently desirable to have the capacity to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to eliminate 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. Median filter is that the easy and powerful filter. It's used for reducing the number of intensity variation between one component and also the alternative component. During this filter, we tend to replace part worth with the average. The median is calculated by initial sorting all the component worth's into ascending order so replaces the component being calculated with the center component value[4][5]. In signal transforming, it is frequently attractive to have the capacity to perform a noise reduction on a picture or signal. The median filter is a non-linear digital filtering system, frequently used to uproot commotion. Such clamor diminishment is an average preprocessing method to enhance the consequences of later preparing (for instance, edge location on a picture). Median filtering is broadly utilized as a part of advanced picture handling on the grounds that, under specific conditions, it preserves edges while uprooting clamor. Average filter is that the simple and compelling filter. It's utilized for decreasing the quantity of power variety between one and furthermore the option segment.

$$L(u,v) \rightarrow mid\{|(u+i,v+j)|(i,j) \epsilon R\} \rightarrow (4)$$

Weiner's 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 of 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 goal of the Wiener filter is to filter out noise that has corrupted a signal. It is based on a statistical approach. Typical filters are designed for a desired frequency response. However, the design of the Wiener filter takes a different approach. One is assumed to have knowledge of the spectral properties of the original signal and the noise, and one seeks the linear time-invariant filter whose output would come as close to the original signal as possible. Wiener filters are characterized by the following:

1. Assumption

signal and (additive) noise are stationary linear stochastic processes with known spectral characteristics or known autocorrelation and cross-correlation

2. Requirement

the filter must be physically realizable/causal[7] (this requirement can be dropped, resulting in a non-causal solution)

3. Performance criterion

minimum mean-square error (MMSE)

This filter is frequently used in the methodology of de-convolution. The Wiener filtering is

optimal in terms of the mean square error. In other words, it minimizes the overall mean square error in the process of inverse filtering and noise smoothing. The Wiener filtering is a direct estimation of the first picture. The approach is based on a stochastic framework. The orthogonality principle implies that the Wiener filter in Fourier domain can be expressed as follows:

$$W(f_1, f_2) = \frac{H^*(f_1, f_2) S_{xx}(f_1, f_2)}{|H(f_1, f_2)|^2 S_{xx}(f_1, f_2) + S_{\eta\eta}(f_1, f_2)} \rightarrow (5)$$

IV. EXPERIMENTAL ANALYSIS

A set of 50 images had been taken for investigation. Each image is subjected to different types of noise mentioned above. Each image with added noise is subjected to different types of filters. The filtered image is compared against the original image using the following image quality measures. Results of each image quality parameter shown below

A. Peak Signal – to – Noise Ratio (PSNR)

The PSNR is termed as peak signal to noise ratio is represented in the form of between maximum power of a signal and representation of corrupted noise. The renovation of image is performed to enhance the quality of measure. The PSNR value is generally represented by reconstruction of higher resolution or quality image. The PSNR value should be always between the range of 30DB and 50DB. The PSNR value is measured using decibel and the value always should be higher[9]. The higher value of the PSNR, the improve the quality of the compressed or recreated image. PSNR is most commonly used to measure the quality of reconstruction of lossy compression codes (e.g., for image compression). Then the block computes the PSNR using the subsequent equation:

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

$$MSE = \frac{1}{mn} \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i,j) - K(i,j)]^2$$

X is the maximum variation in the input image data type. If the input image has a double-precision floating-point and 8- bit unsigned integer then X is 1 and 255 respectively.

Table 1
PSNR Value for images related to different noises with different filters

PSNR Value				
Filter/Noise	**Salt & Pepper Noise**	**Gaussian Noise**	**Poisson Noise**	**Speckle Noise**
Mean Filter	28.3925	28.151	36.9497	39.6813
Median Filter	48.0857	29.0738	33.4819	38.4002
Weiner Filter	23.5249	27.8382	33.0079	37.0661
Gaussian Filter	29.5146	28.7055	38.0005	40.5475

Figure 5 represents the pictorial representation of Table 2. The PSNR value is higher in median filter over the salt and pepper clamor. Gaussian channel gives the most astounding worth for the all other sort of clamors over the picture. Wiener channel and mean channel demonstrates the normal execution over the all different sorts of clamor. In this execution PSNR measures it is clear that the best bring about average channel over a salt and pepper clamor just and Gaussian filter evacuate the Speckle commotion, Poisson Noise and Gaussian Noise than different filter.

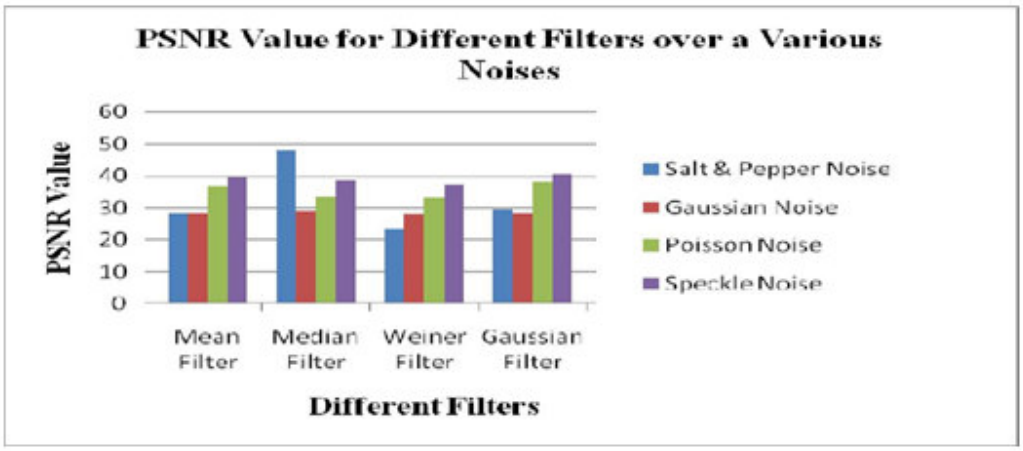

Figure 5
PSNR Value for images related to different noises with different filters

B. Mean Square Error (MSE)

The MSE denotes the collective squared error between the compressed and the original image, whereas PSNR denotes an amount of the highest error. The smaller the value of MSE the smaller the value of error[11]. To compute the PSNR, the block first computes the mean-squared error using the subsequent equation:

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2$$

Table 2
MSE Value for images related to different noises with different filters

MSE Value				
Filter/Noise	**Salt & Pepper Noise**	**Gaussian Noise**	**Poisson Noise**	**Speckle Noise**
Mean Filter	93.4129	99.7794	13.1485	6.9875
Median Filter	1.0311	80.9181	29.2698	9.3372
Weiner Filter	287.2822	107.0784	32.6489	12.8201
Gaussian Filter	72.1603	87.844	10.3035	5.7211

Figure 6 demonstrates the table 1 graphical representation Figure. In which the MSE estimation of the picture is demonstrating the least esteem concerning median filter over salt and pepper clamor. Be that as it may for all other kind of noisy image represents the most minimal quality for Gaussian filter. Weiner filter shows normal execution over all kind of noise likewise emulated by mean filter.

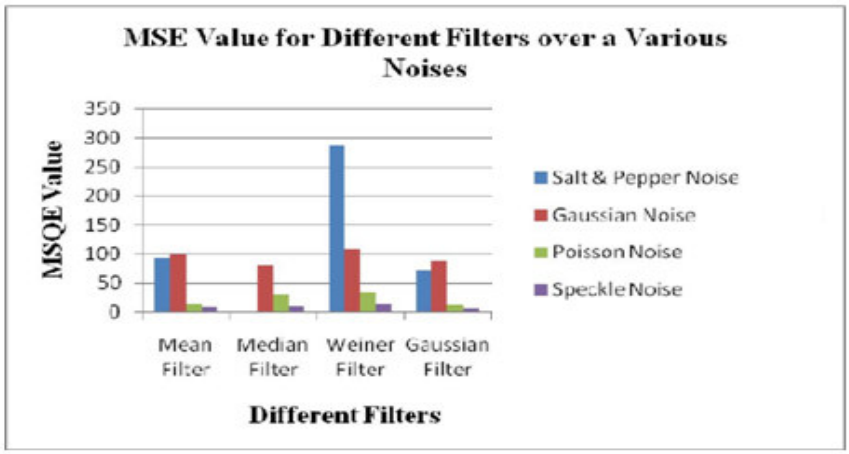

Figure 6
MSE Value for images related to different noises with different filters

C. Normalized Cross Correlation (NCC)

The relationship between the two different images is calculated based on correlation coefficients. Cross correlation is the similarity measures of two images under various intensity illuminations. The Correlation can be calculated based on the two set of variables, in the fundus images the intensity and quality can be taken for the process. The normalized correlation measures are calculated between the two images based on mean and standard deviation by subtracting and dividing respectively. The normalized patches of image pixel intensity range between -1 to 1(positive and negative).

$$NK = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}[f(i,j).f'(i,j)]}{\sum_{i=1}^{M}\sum_{j=1}^{N}(f(i,j))^2}$$

Table 3
NCC Value for images related to different noises with different filters

NCC Value				
Filter/Noise	**Salt & Pepper Noise**	**Gaussian Noise**	**Poisson Noise**	**Speckle Noise**
Mean Filter	1.0046	1.0002	0.999	0.9991
Median Filter	0.9997	1.0000	0.9987	0.9992
Weiner Filter	1.0039	1.0000	0.9993	0.9994
Gaussian Filter	1.0044	1.0001	0.9989	0.999

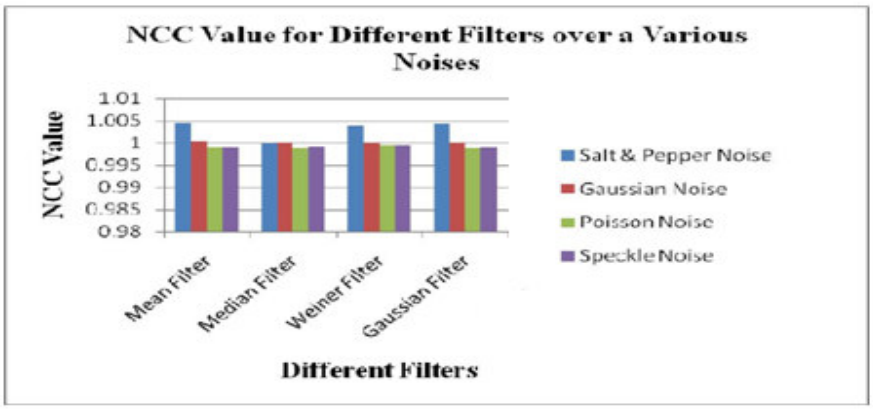

Figure 7
NCC Value for images related to different noises with different filters

Figure 7 shows the pictorial representation of Table 3.The NCC value of a estimated image exposed to median filter over all the other types of clamor shows 1 or close to 1, which is followed by other types of filter.

D. Normalized Absolute Error (NAE)

Normalized absolute error is minimum value in which the variance between original image and normalized image. It is measure of original image value should be less or zero compared with denoised image. The Normalized Absolute Error (NAE) is represented as,

$$NAE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}\left[\hat{I}(i,j) - I(i,j)\right]}{\sum_{i=1}^{M}\sum_{j=1}^{N}\left|I(i,j)\right|}$$

The value close to zero represents better method. The larger value represents poor quality of the image.

Table 4
NAE Value for images related to different noises with different filters

NAE Value				
Filter/Noise	**Salt & Pepper Noise**	**Gaussian Noise**	**Poisson Noise**	**Speckle Noise**
Mean Filter	0.0859	0.1737	0.0329	0.0431
Median Filter	0.0113	0.1308	0.0387	0.0636
Weiner Filter	0.0822	0.1828	0.0415	0.0649
Gaussian Filter	0.0814	0.1651	0.0293	0.038

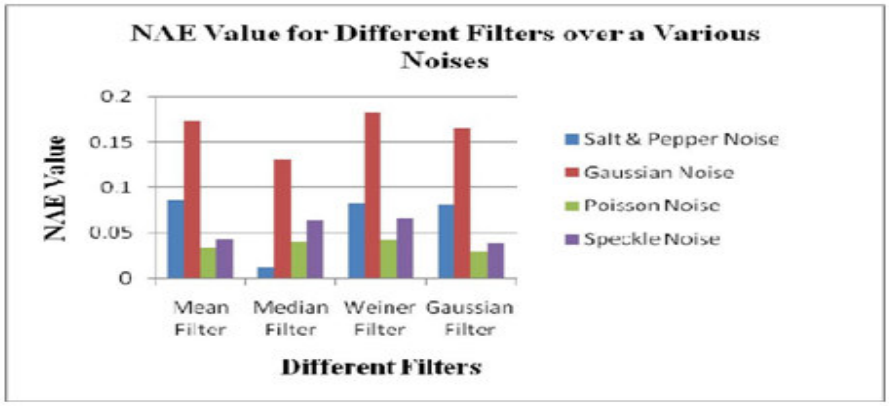

Figure 8
NAE Value for images related to different noises with different filters

Figure 8 shows the pictorial representation of Table 4.The NAE value of an image represented to median filter over salt and pepper noise contain the least value. For all the other type of noise the Gaussian filter shows the lesser value for Normalized Absolute error. Mean and Wiener filter demonstrates the average performance over all the type of noise.

V. CONCLUSION

The various linear and non-linear filters are used to de-noise a medical image. This paper compares the various noises like Gaussian, Salt and pepper, Poisson and Speckle noise which is eliminated by different filters Median, Mean (Average filter), Wiener filter and Gaussian filter. In which the brain image is removed by using different filters. From the results shown above with various performance over salt & pepper noise is clear that the median filter shows best but with other noise it doesn't work well. Hence it is concluded that image acquisition phase of a brain image Weiner filter is an optimum filter.

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