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A Comparative Study of Noise Deduction in Brain MRI Images

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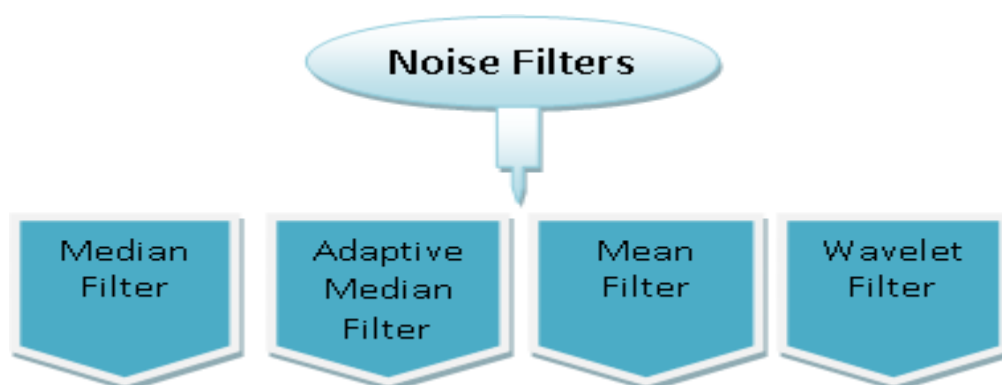
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ABSTRACT-The original information in medical photographs is damaged by numerous sounds and blurs the aspects that are critical for determining the human body's sickness. Denoising MRI images is critical for increasing visual quality and ensuring the accuracy of quantitative diagnostic and treatment analyses. The removal of noise from medical images is a crucial task in pre-processing, and there are a variety of approaches for doing so. In this article various denoising algorithms like Median filter (MF), Gaussian filter (GF), and Mean filter (MEF), nonlocal means, principal component analysis, bilateral are compared with suggested which is the best algorithm to de-noise the MRI Image and finally various evaluation metric are compared.

KEYWORD: Noise, De-noise, De-noise algorithms, Evaluation Metrics.

I. INTROCUCTION

Medical image processing has recently attracted a large number of researchers and is being used in a variety of medical sectors. One of the most widely utilised imaging modalities for clinical diagnosis and treatment is magnetic resonance imaging (MRI). The signal-to-noise ratios in MRI pictures are often low (SNRs). MRI (Magnetic Resonance Imaging) images are the most commonly used in the treatment of various diseases. However, the presence of various noises in those images is the main issue. The noises provide the user incorrect information and cause them to be treated incorrectly. As a result, the content of the information should be devoid of noise and of high accuracy [2, 3]. In this article we discussed the filters like Median, Adaptive Median, Mean & Wavelet filter and finally results which filter works better when they are used in Gaussian noise and Impulse noise. Figure 1 shows the filters that are discussed in this article.



II LITERATURE REVIEW

B.Deepa [4] et al devised noise removal algorithm from 0 Db to 30 Db noise level is evaluated an in average ICA method gives superior value than other in salt and pepper and Gaussian noise, other hand wavelet method is better in removing speckle and Brownian noise.

Hanafy M. Ali [5] investigated three noise filtering methods and concluded that median filter performs good in Gaussian Noise and Adaptive Median Filter performs good in salt and pepper noise

Iza Sazanita Isa [6] et al evaluated the performance of three filtering methods and the result shows that Median filter outperformed in Gaussian and salt & pepper noise and average filter is prone to speckle noise.

M. Latha [7] et al calculated PSNR, SNR, and MSE for three filters and shows Wiener filter gives higher performance than median and mean in Gaussian noise.

N.Rajeswaran [1] et al suppressed wavelet thresholding method and in that The Bayes shrink method

Performs well and gives higher PSNR value.

1. SOURCES OF NOISE IN DIGITAL IMAGES

Various sources of noise can degrade digital images during the acquisition and transmission phases. Many image processing approaches suffer as a result of this degradation, and a pre-processing module to filter the images is frequently necessary.

Noise sources

- Image acquisition
- Image transmission

2. NOISES IN IMAGE

Digital images, like image processing, are very sensitive to noise, which is caused by image acquisition and transmission faults. Speckle noise, Gaussian noise, and salt and pepper noise are common in MRI pictures, all of which have an impact on image quality [8].

So far, a variety of MR image de-noising algorithms have been developed, each with its own set of benefits and drawbacks. According to this research, the technique used is dependent on the type and amount of noise in the MR picture. Other parameters to examine are performance in de-noising MR images, computational time, and computational cost.[9-12]

4.1 Gaussian noise

It is also known as the Gaussian distribution. The normal distribution provides a probability density equation for Gaussian noise. During image acquisition, Gaussian noise or amplifier noise is added to the MR picture, such as sensor noise caused by low light, high temperature, or transmission, such as electronic circuit noise. Spatial filtering (Adaptive Wiener filter, Median filter, Wiener filter, and Adaptive Median filter) will be used to remove the noise. The following equation and Figure 1 demonstrate the Probabilities Density Function (PDF) of Gaussian Noise:

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

P(x) is the Gaussian distribution for noise in an MR image, and μ and σ are the mean and standard deviation, respectively. The figure 1 shows the example of Brain MRI image that is affected by Gaussian noise

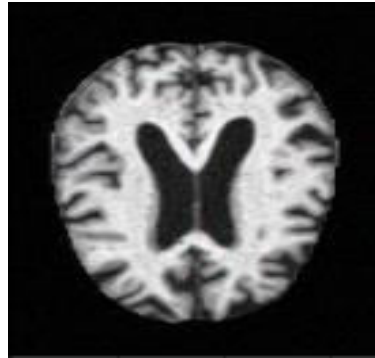


Figure 1: Gaussian Noise in Brian MRI image

4.2 Impulse noise

Salt & Pepper noise or Spike noise are other names for Impulse noise. It's caused by broken pixels in camera sensors, incorrect hardware memory locations, or transmission over a noisy channel. It will always be independent and unrelated to the pixels in an MR image. The salt-and-pepper noise and random-valued noise are the two types

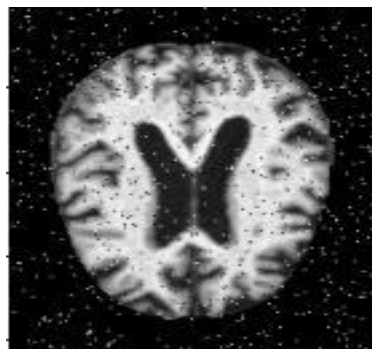


Figure 2: Salt & Pepper Noise in Brain MRI Image

The noisy pixels of the Salt and Pepper kind of noise take either a salt (grey level 225) or a pepper (grey level 0) value, resulting in black and white patches on the MR pictures. In the case of random valued impulse noise, the grey level value can range from 0 to 225. In this situation, noise is similarly randomly distributed across the entire MR picture, and the probability of any grey level value appearing as noise is the same. Figure2 shows the example of Brain MRI image that is affected by Salt & Pepper noise

III. IMAGE DENOISING TECHNIQUES

5.1 Median filter

The median filter examines each pixel in the image individually and compares it to its neighbours to determine whether it is representative of its surroundings. Rather than merely replacing the pixel value with the mean of nearby pixel values, the median of those values is used instead. The median is derived by numerically ordering all of the pixel values in the surrounding neighbourhood and then replacing the pixel in question with the middle pixel value. (If the number of pixels in the neighbourhood under consideration is even, the average of the two middle pixel values is utilised.) An example calculation is shown in Figure 3.

124	120	130	123	140	Neighbourhood values:					
123	123	127	126	124		124	115	120	119	125
233	120	125	120	134		123	127	120	126	
243	124	115	119	133	Median value=123					
230	237	239	250	139						

Figure 3: Example calculation of Median Filter

5.2 Adaptive median filter

Adaptive median filter to be able to distinguish between small details and impulse noise, a filtering algorithm was developed. This filter analyses the image's local variability and seeks to replace just the pixels that have been corrupted by impulse noise while keeping fine features.

5.3 Mean filtering

Mean filtering works by simply replacing each pixel in an image with the mean (average) value of its neighbours, including itself. As a result, pixel values that aren't typical of their surroundings are removed. Mean filtering is often mistaken for a convolution filter. It is built on a kernel, which represents the form and size of the neighbourhood to be sampled while calculating the mean, just like other convolutions. Figure 4 shows how a 3*3 square kernel is commonly employed, however bigger kernels (e.g. 5*5 squares) can be used for more severe smoothing.

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$
$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

Figure 4: Example calculation of Mean Filter

5.4 Wavelet transform

The wavelet transform is one of the most promising image denoising techniques. The traditional wavelet transform decomposes the low frequency components to yield the approximation and detail components for the next level; the current level of detail components is preserved [13].



IV. CONCLUSION

Identifying and eliminating noise from an MRI picture is a time-consuming task, as image noise can alter the outcome of any model. The type and amount of noise present in an image determines which filter to use, as demonstrated by this research. Furthermore, the efficacy of de-noising MRI pictures is dependent on the type of noise and filtering algorithms used. As a result, some research papers are analysed in this article, and it is concluded that the Median filter performs well in Salt & Pepper Noise. This review can be expanded to include a variety of noises and filters.

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