



Magnetic resonance Image Denoising Using Different Filtering methods

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Abstract- Image quality is major concern now a days in image processing area, especially in medical images are concern. Noise is major defect in medical images like MRI image, CT scan image etc. For better diagnosis, it is better to have medical image without affecting any noise and other defects. We analyze different noise reduction filters for remove Gaussian noise like, Average Filter, Median filter, Gaussian filter, Disk filter, Wiener filter. This filters are removing Gaussian noise. Then their PSNR and MSE values are compared.

Keywords: Image processing, MRI, CT, Gaussian noise, Average filter, Gaussian filter, Disk filter, Wiener filter.

I. INTRODUCTION

Noise is very major concern in medical image nowadays. Especially when we talk about medical images, noise like, Gaussian noise, salt and paper noise are very common. Due to these noises we face several problems in medical images like, MRI scan, x-ray, ultra sound, brain hemorrhage scanning. And the output of noisy medical images are also poor. To overcome this problem we implemented various filters like Average Filter, Median filter, Gaussian filter, Disk filter, Wiener filter.

Sambit Satpathy, Mohan Chandra Pradhan, Subrat Sharma [1] proposed Gaussian filter, Gabor filter, Box filter, Median filter, Adaptive median filter for removing noise like, Gaussian and Salt and Paper noise. They designed filters using LABVIEW. Comparison of filters are done based on PSNR values which shows Gaussian filter is better.

Ms.Seetha.J, S.Selvakumar Raja [3] shows analysis of the three noise removal techniques and compare them. The three techniques are Gaussian, Gabor, Median filter. Than compare it with parameter like PSNR, Energy, Entropy, Variance, Correlation and Contrast. In this paper Median filter operates well as compare to Gaussian and Gabor filter.

Asim Altaf Shah, M. Mohsin Malik, M. Usman Akram, Shafaat A. Bazaz[2] proposed noise removal techniques for remove speckle noise. They compare Wavelet denoising, bilateral and wiener filter for removing speckle noise. Wavelet denoising shows best results for removing speckle and additive white Gaussian noise.

II. DIFFERENT FILTERS

Filters are nothing but the filter mechanism for different noise in any images. Filter help to remove or reduce the noise in image. When we talk about medical images the image should be clear and clean for best diagnosis results.

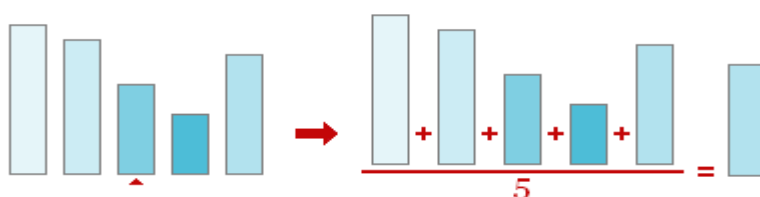
2.1 Different Filter methods:

There are many noise filtering techniques but we used this five technique to evaluate the output.

1. Average Filter
2. Median filter
3. Gaussian filter
4. Disk filter
5. Wiener filter

1. Average Filter:

Mean filter, or Average filter is windowed filter of linear section, that smoothes image. This is lowpass filter, which has idea for any element of the image take an average across its neighborhood[7].



This figure is basic example of taking an average of element of 5 data. This will sum the elements and take average.

In MATLAB the default window for this filter is 3x3. Here the added Gaussian noise is zero mean with 0.01 variance.

2. Median filter:

The median filter is a simple nonlinear filtering technique. Sambit Satpathy and et.[1] proposed that this is popular used as remove noise. Which is also used in medical images for removing various noise. Median filtering is very widely used in medical image processing because, under certain conditions, it maintain edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with each entry with the median of neighboring entries[8]. In a median filter, a window is allowed to move along the image and the pixels with the median intensity value, across the window and becomes the output intensity of the pixels that are processed. The process of filtering starts with storing the neighbor. Then it sort the window in numeric order, and last it will select the median value from calculated window number[1].

Median filter has 3x3 matrix of neighborhood around the corresponding pixel of input. MATLAB has function for 2D median filter by medfilt2. Mathematical equation for calculating intensity is[3]...

$$T(x, y) = I(n \times n) / 2$$

$$I_1 \leq I_2 \leq I_3 \leq \dots \leq I_n \times n$$

Where, I is intensity of the pixel. $I(n \times n) / 2$ is intensity of middle pixel. Which will be selected as new pixel value.

3. Gaussian filter:

Remove the noise from image is very important part of preprocessing. Gaussian filter is filter with impulsive response. Gaussian filter reduce execution time while overshoot the to input data[1]. that's why Gaussian filter is least possible group delay. Mathematically, a Gaussian filtering method amends the input signal by convolution to a Gaussian function, this conversion is called the Weierstrass transform. The main process of reducing noise is done by linear filter like Gaussian filter. The mathematical equation for Gaussian filter represented by[3],

$$g(x, y) = \frac{1}{2\pi\sigma^2} \cdot e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where, x=distance between origin and horizontal axis.

Y= distance between origin and vertical axis.

σ =Standard deviation for Gaussian distribution

The default value for a vector specifying the number of rows and columns of filter window is 3x3. The default sigma is 0.5.

4. Disk filter:

Disk filter is basically averaging filter with circular effect. This is also a low pass filter. Which is also used in medical images for removing various noise. Disk filtering is very widely used in medical image processing when the noise variance is high. Disk filter method is circular averaging with radius of $2 \times \text{radius} + 1$. MATLAB has a function fspecial() to execute disk filter. The default value for radius in MATLAB 2016a is 5.

5. Wiener filter:

Wiener filter is adaptive technique which relay on mean value and variance value. Salim Lahmiri, Mounir Boukadoum [4] proposed Wiener filter degrades constant power additive noise. It is low pass filter. Wiener filter uses a pixelwise adaptive Wiener method based on statistics estimated from a local neighborhood of each pixel. By using neighborhoods size local image mean and standard deviation is decided[10]. The default values for neighborhood is 3.

The mathematical formula of wiener filter is as follow[4],

$$u(x, y) = \mu + \frac{\sigma^2 - v^2}{\sigma^2} (u_0(x, y) - \mu)$$

Where, v^2 is the average value of σ^2 across u_0 .

σ and μ are describe as follow[4]..

$$\mu = (XY)^{-1} \sum_{x,y \in W} u_0(x, y)$$

$$\sigma^2 = (XY)^{-1} \sum_{x,y \in W} (u_0^2(x, y) - \mu^2)$$

μ is local mean and σ is variance, u_0 noisy image, (x,y) is pixel position, w is averaging window.

6. Performance measure:

Performance is measured by peak-signal-to-noise-ratio. Which is calculated by

$$PSNR = 20 \log_{10} \left(\frac{MAX_f}{\sqrt{MSE}} \right)$$

Where, MAX is the maximum signal value in the original image f of size $m \times n$, and MSE is the mean squared error.

III. IMPLEMENTATION

Implementation of this five techniques is done in MATLAB 2016a tool. For implementation we use 50 MRI image dataset. We have insert white Gaussian noise in all the medical image by `imnoise()` function in MATLAB. The mean is zero and variance is 0.01.

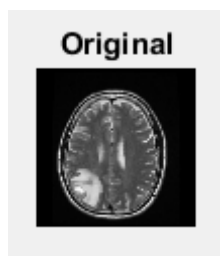


Fig : First original image



Fig : remove noise with Gaussian filter



Fig : remove noise using average filter



Fig : remove noise using median filter



Fig : remove noise using disk filter

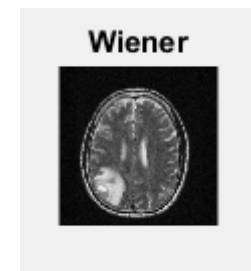


Fig : remove noise using wiener filter

Figure 1: first MRI image noise reduction using different filter method

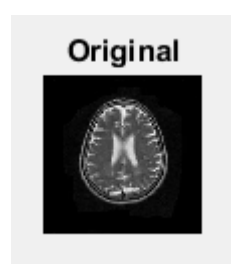


Fig : second original image

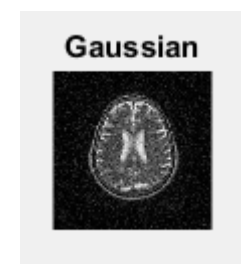


Fig : remove noise with Gaussian filter

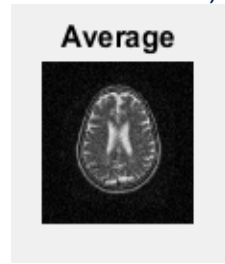


Fig : remove noise using average filter

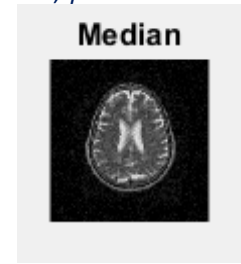


Fig : remove noise using median filter



Fig : remove noise using disk filter

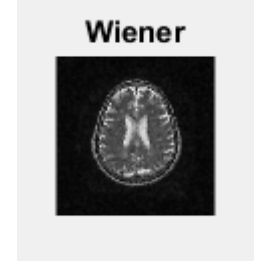


Fig : remove noise using wiener filter

Figure 2 : second MRI image noise reduction using different filter method

The PSNR value for each method are...

For first image,

Gaussian filter → 24.6977

Average filter → 28.0404

Median filter → 28.4137

Disk filter → 24.5805

Wiener filter → 27.4143

For second image,

Gaussian filter → 24.7974

Average filter → 26.4085

Median filter → 27.4354

Disk filter → 22.953

Wiener filter → 26.6253

The average values of noise remove method implemented on 50 different MRI images are analyze as follow..

Denoise technique	PSNR
Gaussian filter	24.6247
Average filter	27.2514
Median filter	27.6508
Disk filter	24.3457
Wiener filter	26.6326

Table 1: Average PSNR for 50 image

Figure shows all the five filter techniques for noise reduction and its visual assessment. This shows that all method shows visually better results. Applied implementation of all five method for noise removal shows good results. These methods are applied to all 50 image dataset. The output results show the visual difference as per shown in figures, and PSNR values are compared. PSNR values shows that for removing Gaussian noise Median filter shows best results among all other filter methods.

IV. CONCLUSION

Recently much research is going on for best noise removal technique. We compare five filter method for removing Gaussian noise from MRI images. The experiment results analyze Median method shows best result with PSNR value 27.6508. This is best method among all five filter.

VII. ACKNOWLEDGEMENT

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