A Discussion on various De-noising Techniques

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Abstract

Image denoising aims at retrieving a clean image from a noisy image. In every image there is a lot of noise identified due to Imperfect instruments, problems during data acquisition, transmission, Camera misfocus etc[2]. This will damage the image resolution and no clarity for the images. Image Restoration removes or reduces the degradation that occurred during image capture Denoising images remains as a challenger to the Researchers because removal of noise introduces artifacts and causes images to blur. Some of the mage Denoising techniques were discussed here.

Keywords: De-noising, Image Filtering, Median Filters, Gaussian noise, Salt and Pepper noise, Speckle noise.

INTRODUCTION

A picture is worth thousand words.

Noise is an un desirable signal, which interferes with the original signal, degrades the image's Quality. Various images inherit various kinds of noises [1].

Noise Models:

1. Additive

2. Multiplicative

3. Impulse

Impulse noise changes pixel values at random [1].

In additive model, noise will be appended to original signal for producing corrupted image.

In case of Multiplicative model, noise got multiplied with the original signal and generates corrupted image [4].

Classification of Noises

Poisson noise: Also referred to as shot noise. Follows distribution which is close to Gaussian distribution [1]

Gaussian Noise: This is also termed as amplifier noise. This noise has bell shaped probability distribution function .This occurs during image acquisition or transmission. This is an additive noise model [4].

Salt & Pepper noise: This is an Impulse noise. It happens due to errors in transmission. In case of an 8 bit image, pepper noise value is 0 and salt noise value is 255.

Any image with salt and pepper noise will have dark pixels in luminous regions, bright one in dark areas [4].

Speckle Noise: Speckle noise is an multiplicative model noise [3].

Image Denoising:

Image Denoising aims at recovering digital image which has been contaminated

Restoration of images is the course toward taking a corrupt/noisy image and surveying the ideal, fascinating picture

It implies disguise of the effect of the noise, along these lines resultant image ends up satisfactory. There are two fundamental methods for images de-noising transform space and Spatial isolating systems. Spatial space designs work particularly on picture pixels, where as transforming region designs are depending after modifying Fourier or wavelet change of the image. A couple of de-noising schemes are accessible for removal of settled inspiration noise value in light of their profitability in commotion transfer and effortlessness of utilization. Standard center channel (SMF) is broadly used for its straightforwardness and noise elimination ability. Regardless, this channel ends up being great at a little uproar thickness in light of the way that as upheaval thickness enhances the edges of the picture are not ensured. This drawback was overpowered by the introduction of a couple of various strategies for the transfer of SPN [5].

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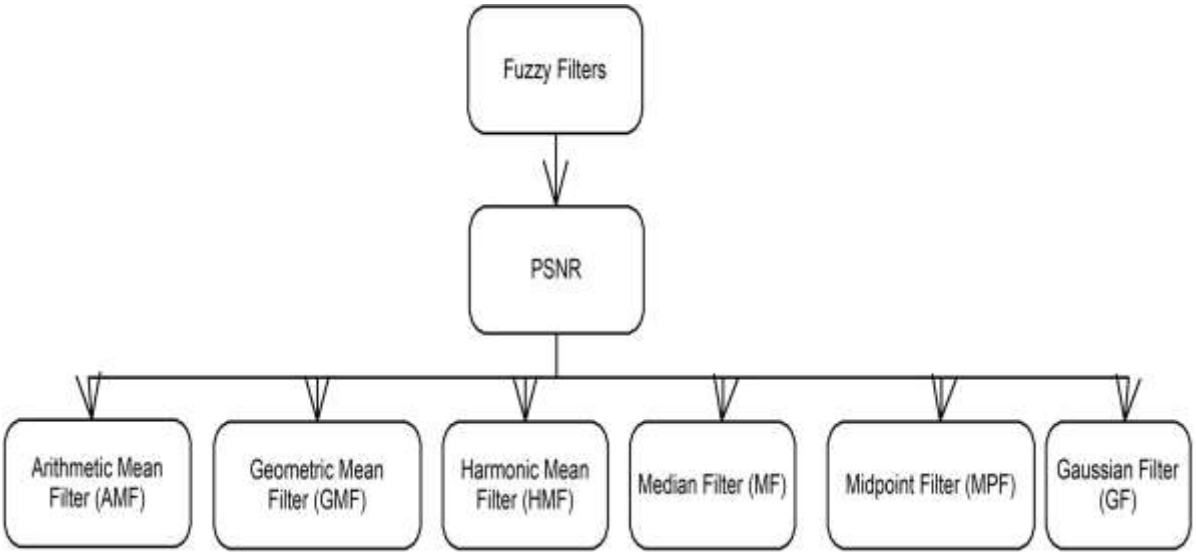

Figure: 2, Various Fuzzy Classical Filters

VARIOUS DENOISING TECHNIQUES

While ordering the different de-noising channels, we characterize the channels in 2 general classes. These are

(i) Traditional filters

(ii) Fuzzy based filters

A. Traditional Filters

These are the filters that are more generally used to eliminate noise from corrupted images. These are classified into two classes:-
(i)Spatial Domain
{ii) Transform Domain.

1. Spatial Domain

Spatial filters are classified in to following categories.
(i) Linear
(ii) Non Linear

Linear Filters blurs the sharp edges destroys other details of the image. Mean, Wiener and Laplacian are some of the linear Filters [6]

wiener filter provides the best results in case of Gaussian, Poisson noises. For drive bustle, centre filter [4], beats each and every other filter. Diverse enhanced centre filters like weighted centre filter [5] is furthermore used thus.

2. Transform Domain

It is required when it is critical to analyze the signal. Here, we change the offered signal to another space and do the de-noising procedure there and therefore switch of progress is done with the ultimate objective to get last yield. There are a couple of changes open like the Fourier change, Hilbert change, wavelet change, et cetera. The Fourier change is likely the most notable change. Among different Fourier changes [1] brisk Fourier Transform (FFT) is seen as the best. In any case the Fourier change does not give prevalent if there ought to emerge an event of image denoising. Wavelet change is better thus [3]. Wavelet change further give differing systems to ousting confusion from image which noise Thresholding, non-symmetrical wavelet change and coefficient show.

B. Fuzzy Based Filters

Fuzzy based filters are those channels which incorporate idea of fuzzy rationale in their separating methodology. Fuzzy based filters can likewise be additionally ordered into two classifications: fuzzy traditional and completely fuzzy.

1. Fuzzy Classical Filters

Fuzzy classical filters contain the filters which extend the traditional filters using fuzzy logic. There are plenty of fuzzy traditional filters on which many researchers have worked. Some of popular fuzzy classical filters are:

- **Arithmetic Mean Filter (AMF):**

  It finds the arithmetic mean of the pixel values present in window. This will smooth the differences within the image.

- **Geometric Mean Filter (GMF)**

- the product of the pixel values within the window, raised to the 1/n*m power.

- **Harmonic Mean Filter (HMF)**

  In this process, the color value of each pixel is replaced by the harmonic mean(H.M) of color values of the pixels in a surrounding region.

- **Median Filter (MF)**

  In this filter, the pixel values in the window W is first ordered from smallest to largest.

- **Midpoint Filter (MPF)**

  After ordering the values in the n*m window, W, midpoint filter is the average of the maximum and minimum values in the ordered set [3].

- **Gaussian Filter (GF)**

  It uses Gaussian distribution for removing or eliminating noise occurred in images.

2. Fully Fuzzy Filters

Fully fuzzy filters completely related to fuzzy logic and differ with most commonly used methods. Some of the Fully Fuzzy Filters are:

• Dual Step Fuzzy Inference Ruled by Else-action filter (DSFIRE) [15]

• Piecewise Linear Fuzzy Inference Ruled by Else-action Filter (PWLFIRE) [16]

• Gaussian noise reduction filter (GOA)[17]

• Histogram Adaptive Filter (HAF) [18]

• Fuzzy Inference Ruled by Else-action filter (FIRE) [14]

There are other filters to be had. We merely note, as it were, a portion of the prevalent filters. FIRE [14], channels are a collection of nonlinear filters receiving fuzzy tenets for the processing of picture or image information. Double Step FIRE filter [16], receives fuzzy thinking at two separate unique levels with the ultimate aim of dropping clamor beats without damaging the better image structures. DS-FIRE channel can be expanded to a great extent outflank other strategies in the writing. All fuzzy based channels utilize fuzzy guidelines based frameworks to integrate fuzzy rationale in to it.

Measures of Image Quality:

Image quality can refer to the level of accuracy in which the various
Image quality can refer to the level of accuracy in which the various Imaging sys tems capture, process, store,compress, tran smit and display the image-forming signals

Comparing results obtained from restoration requires measurement of image quality.
Two most commonly used methods are Mean-Squared Error (MSE) and Peak Signal-to-Noise Ratio (PSNR). Between two images $g(x, y)$ mean-squared error (MSE) is:

$$e_{MSE} = \frac{1}{MN}\sum_{n=1}^{M}\sum_{m=1}^{N}[\hat{g}(n,m) - g(n,m)]^2$$

The PSNR in decibels is adopted for denoising efficiency measurement and is given by :

$$\text{PSNR} = 10\log_{10}\frac{M\times N\times T^2}{\sum_i\sum_j[d(i,j)-d'(i,j)]^2},$$

Where $M \times N$ characterize the image size, T^2 designate the highest possible value that may be attained by the image signal, $d(i, j)$which represents the pixel-values of original & processed images, respectively. The highest PSNR symbolize the better de-noising efficiency.

MSE is the one of the important image quality metric which compares the 'original' pixel value with the image. MSE measures the average of the squares of errors between original and the noisy images.

Filter	Noise without Peak Signanl Noise Ratio	Noise with PSNR
AMF	60%	92%
GMF	67%	91%
HMF	71%	89%
MF	69%	90%
MPF	47%	94%
GF	56%	87%

Table: 1 shows the performance of the PSNR with sample image filters.

Literature Review:

1. R Srinivas, Sata Rupa Panda in "Performance Analysis of Various Filters for Image Noise Removal in Different Noise Environment ", International Journal of Advanced Computer Research (ISSN (print): 2249-7277 ISSN (online): 2277-7970) Volume-3 Number-4 Issue-13 compared the performance of four filters Average Filter, Adaptive & Standard mean filters ,Alpha trimmed median filters on the images effected with Gaussian, Salt and pepper and speckle noises under various densities ranging from 10% and up to 60%. For verifying the efficiency of filters, Mean Squared Error (MSE) and Peak signal to nosie Ratio (PSNR) were applied.
It was concluded that standard Median filter is more effective for removing salt & pepper noise with density up to 50% and for noises having density more than 50%, Average filters is more suitable.
In case of Gaussian noise, Average & Adaptive Filters performs better than others.

Alpha trimmed Filter is not effective in minimizing or reducing any of the given chosen noises.

2. Manoj Guptha et al., in "Performance Enhancement and Analysis of Filters in Ultrasound Image Denoising ", International Conference on Computational Intelligence and Data Science (ICCIDS 2018) discuses about Ultra sound images effected with Salt & pepper, Gaussian , Speckle and poisson noises .Gaussian, Order statistic, bilateral, Mean and Laplacian Filters were sued to eliminate noise from the contaminated images and the efficiency of these filters is measured based on values of PSNR, Mean Squared Error and Root Mean Squared Error respectively. As per the values of PSNR, MSE and RMSE, It may be inferred Mean filer works well in removing Speckle, salt & pepper and poison noises and also Concludes that Gaussian Filters works well in eliminating Gaussian noise effectively against other filters.

These are scope for expanding this work for RGB and Binary images.

3. V Rabila, G. Bharatha Sreeja in " Survey On Image Denoising Using Various Techniques ", International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056 Volume: 03 Issue: 08 | Aug-2016 described the significance of digital images in research as well as in Education and medical Fields. Various Image Denoising techniques such as Wavelet soft Thresholding, Hard Thresholding, Genetic Algorithm and BM3D-SAPCA were measured using the metrics PSNR and MSE. Based on values of Peak signal to Noise Ratio, it was concluded that BM3D-SAPCA performs better compared to remaining methods.

4. G. Vasavi and S Jyothi in " A Comparative Study of Speckle Reduction Filters for Ultrasound Images of Poly Cystic Ovary "discussed about the importance of Ultra sound images in diagnosing the human diseases. Mostly these will be degraded due to presence of speckle noise in these images. Various filters such as Median, Weiner, Guided Filters, Optimized Basian non local means Filter etc. In this paper, 5 ultra sound images were taken for the experiment conducted in MATLAB and Speckle nosie with 0.04 is added to the images. PSNR, SSIM ,SNR and MSE were used as metrics for measuring the efficiency of the filters in reducing speckle noise. Based on the results obtained , it was concluded that OBNLM is more efficient than others in eliminating speckle noise present in the ultra sound images.

Conclusion:

Different image De-noising Filters are discussed in this paper for further enhancement of image quality. . Wide range of filters is described in this paper with their features and advantages and also some of the techniques are explained.

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