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RESEARCH ARTICLE

DENOISING BASED ON MULTI-LEVEL FILTERING IN IMAGE PROCESSING

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ABSTRACT

This paper presents a new denoising based multi-level filtering technique algorithm for image restoration. It is designed to eliminate the errors or quality degradation in image by the means of multi filtering techniques. This work uses Pseudo Inverse Filter and Wiener Filter techniques of filtering. With the help of this hybrid method, proposed work denoises the image and improve the quality of the image. Digital image processing has been and will continue tohave an important role to extremely varied applications. Proposed work is implemented in .NET. Results show very much clearly about the restoration of degraded image.

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INTRODUCTION

Image noise is an undesirable by-product of image acquisition or transmission. Denoising is one of the important pre-processing steps in various image processing and analysis applications. The main aim of image denoising is to remove noise while preserving the important signal features. Noise reduction techniques are conceptually similar regardless of the image being processed; however a prior knowledge of the characteristics of an expected image can govern the implementations of these techniques. A total figure of de-noising techniques are present for the removal of several types of noises like as Gaussian, Speckle, Salt & Pepper etc. where linear and non-linear techniques are also there. Noise possesses Gaussian-like distribution is mostly found in real-world images. The zero mean property of that Gaussian distribution permits that noise to be eradicated through locally averaging pixel values. Past linear filters like as arithmetic mean filter and Gaussian filter smooth noises strongly but distort edges and contours (Jimmy Singla, 2012). The Wiener filter refers as mean square error-optimal stationary linear filter for the purpose of images degraded through additive noise and blur. A general disadvantage of the actual use of this technique is that they usually require some 'a priori' information about the spectra of that noise and the actual signal. Unluckily, such information is mostly not available. This makes the linear orspatial techniques less attractive for image denoising. Alternatively non-linear methods were proposed for denoising. They are mostly based on multi-resolution analysis using wavelet transform (Yun Yin *et al*., 2011; Pradnya *et al*., 2012). Here in wavelet domain, the noise is constantly spread over the coefficients, at that time overall image information is focused on few largest ones due to its sparse representation. The most straightforward way of distinguishing information from noise in the wavelet domain consists of thresholding the wavelet coefficients (Donoho and Johnstone, 1994). A coefficient of wavelet is then compared with known threshold and is taken to zero, when the magnitude is low as compare to threshold; or it is kept or modified depending on hard or soft thresholding schemes. Since 2-D Wavelet is tensor product of 1-D Wavelet, it has only three directions, viz. vertical, horizontal and diagonal. So 2-D Wavelet is effective at approximating point singularities than line singularities like edges. The tensor product wavelet do not adapt to the boundaries or edges, due to isotropic scaling of its basis functions. Therefore a more effective basis for real-world images with edges and curves is required for making the signal to concentrate on fewer coefficients after transformation.

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De-noising is used in various areas such as

- Remote Sensing
- Medical Imaging

- Non-destructive Evaluation
- Forensic Studies
- Textiles
- Material Science.
- Military
- Film industry
- Document processing
- Graphic arts
- Printing Industry

2. IMAGE PROCESSING

Image Processing is taken as a method to increase the raw images taken from cameras/sensors present on satellites, space probes and aircrafts or pictures clicked in normal day-today life for several applications.

There are two methods present in Image Processing.

2.1 Analog Image Processing

Analog Image Processing known as the alteration of image with the help of electrical means. The most common example is the television image. The television signal referred as voltage level which varies in amplitude to represent brightness through the image. By electrically varying the signal, the displayed image appearance is altered. The brightness and contrast controls on a TV set serve to adjust the amplitude and reference of the video signal, resulting in the brightening, darkening and alteration of the brightness range of the displayed image.

2.2 Digital Image Processing

In Digital Image Processing, digital computers are implemented to process the image. Here the image will be transformed into digital form through a scanner – digitizer (KMM *et al*., 1997) and after that processes it. It is known as the subjecting numerical values representations of various objects to a sequence of operations for getting the desired result. It begins with single image and do some modification in that same image. Hence, it's a process which convert an image into other image . The word digital image processing mostly relates to processing of a two-dimensional image through a digital computer (Pawar *et al*., 2011; Verma and Sharma, 2010). In a wider context, it shows digital processing of two-dimensional data. A digital image refers as array of actual numbers shown through a finite number of bits.

3. DE-NOISING

The image s(x, y) is blurred through a linear operation and noise n(x, y) is taken to distort the image w(x, y). w(x, y) is then folded with its restoration procedure g(x, y) to create the restored image z(x, y).

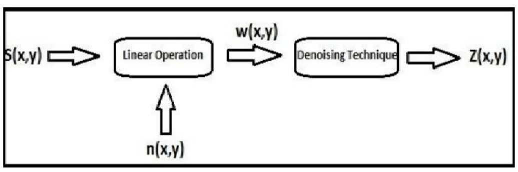

Figure 1. De-noising

The "Linear operation" shown in Figure 1 referred as summation or multiplication of the Noise n(x, y) to their signal or image s(x, y). Once the corrupted or noised image w(x, y) is taken, then there is the application of de-noising method i.e. algorithm to obtain the de-noised image z(x, y). Noise reduction or noise removal are implemented through filtering, with the help of wavelet analysis, or by multi fractal analysis. Each technique have some advantages and disadvantages. Wavelet methods consider thresholdingat that time multifractal analysis is depended on enhancing the Holder regularity of the corrupted image.

4. FILTERING

Noise filtering is used to filter the unwanted information from an image. It is necessary to eradicate several types of noises from those images. Mostly this feature is interactive. Various filters like low pass, high pass, mean, median etc., are available.

4.1. Linear Filtering

4.1.1. Mean Filtering

A mean filter (Gonzalez and Woods, 1992) works on an image through smoothing it, i.e., it decrease the intensity changes in between adjacent pixels. The mean filter define as a general sliding window spatial filter which exchanges the center value in that window with their average of the entire neighboring pixel values including itself. It is implemented on the basis of digital convolution using linear filters, which offers a result which is a weighted sum of their values of a pixel and their neighbors. It is also known as a linear filter. The mask or kernel refers as square. If the sum of the coefficients of the mask is one, after that the average brightness of the image is not altered. If the sum of coefficients is zero, then the average brightness has gone, and dark image is obtained in returns.

4.1.2. LMS Adaptive Filter

The variation in between the mean filter and the adaptive filter (BhabatoshChanda and DwijeshDuttaMajumder) is referred as weight matrix varies after single iteration in the adaptive filter at that time it remains same throughout the iterations in that mean filter. Adaptive filters have the potential for de-noising non-stationary images, i.e., images that have abrupt changes in intensity. An adaptive filter iteratively modify its parameters at the time of scanning the image to cope up with the image generating mechanism.

4.2.Non Linear Filter

4.2.1. Median Filter

The Median Filter (MF) is a non linear digital filtering technique. Median filtering (James C. Church *et al*., 2008) conserves edges at the time of removing noise. The ultimate idea of the median filter is to replace each entry with its median of their neighboring entries. If the window has an odd value of entries, then the median becomes easy to express: it is taken as the middle value after overall entries in the window are being sorted numerically. For some even number of entries, more than one possible median is present. Median filters are widely used as smoothers for image processing, as well as in signal processing and time series processing. The output y of the median filter at the moment t is calculated as the median of the input values corresponding to the moments adjacent to t:

y(t) = median ((x(t-T/2), x(t-T1+1),…, x(t),…, x(t +T/2))……………(1)

4.2.2. FUZZY FILTER

Fuzzy Filter (FF) is based on gray level mapping into a fuzzy plane, using a membership function (MozammelHoqueChowdhury *et al*., 2007). The main motive to create an image of high contrast as compare to the original image through giving a larg weight to that gray levels which are nearer to the mean gray level value of the image as compare to those that are far from the mean. An image f of size M x N and L gray levels are taken as an array of fuzzy singletons, each of them process a value of membership representing its degree of brightness related to few brightness levels. For an image f(x, y), we can write in the notation of fuzzy sets:

f (x, y) = U µ x y / Ix y

4.2.3. WIENER FILTER

The goal of the Wiener Filter (WF) work as to filter out noise which occurred in a signal. It is counts on a statistical work process. The Wiener filters (Wavelet domain image de-noising by thresholding and Wiener filtering, 2003) work processes filtering from a distinct angle. Performance criteria of wiener filter is minimum mean square error.

5. Proposed Work

As we have already studied a number of noises and to remove them there is a quite good category of filters available as:

- Pseudo Inverse Filter
- Wiener Filter
- Inverse Filter
- Weiner Filter and many more.

But to remove maximum possible noise from the signal is not possible with any single filter. So, we have found a new approach for de noising based on multi level filtering. Our filter is a combination of:

PSEUDO-NOISE FILTER and WIENER FILTER

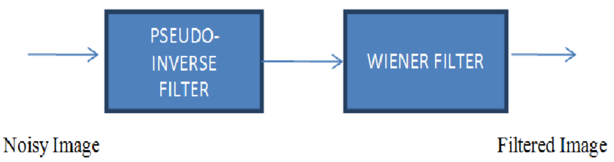

Fig. 2. Pseudo noise filter and filtered image

We are arranging these filters in series to get desired output.

1. Enter the image
2. Resize the image into 256 x 256 size.
3. Initialize the sigma, gamma, alpha variable.
4. If noise ==0
   Add the noise
   Else
   Goto step 4
   End
5. Enter the size of mask or window
6. Calculate fft of the input image, called y.
7. Calculate the fft of the input mask with the level = size of mask.
8. Initialize the point spread function based on the value of row and column of mask
9. Determine the frequency response by Calculating the fft of the point spread function.
10. Perform the Inverse filtering of the frequency response obtained by step 8.
11. Calculate the Inverse fft of the result obtained from step 9 with only considering real part.
12. Calculate the fft of the result obtained from step 10.
13. Calculate the power of function retrieved from step 11.
14. Calculate the S- frequency response using gamma function.
15. Calculate the i- frequency response using gamma function.
16. Calculate the power in consideration with sigma.
17. Calculate the frequency response of the result obtained from step 16, called freqh.
18. Determine the element by multiplication of y and freqh.
19. Determine the inverse fft of the result obtained from step 18 with only considering real part, called final de-noised image.
20. Calculate the SNR of the de-noised image.

Fig. 3. Algorithm for Proposed work

6. Simulation and Results

The selection of the denoising technique is application dependent. So, it is necessary to learn and compared enoising techniques to select the technique that is apt for the application in which we are interested. By far there is no criterion of image quality evaluation that can be accepted generally byall.Atechniquetocalculatethesignaltonoiseratioinimageshasb eenproposed which can be used with some approximation. This method assumes that the discontinuities in an image are only due to noise. For this reason, all the experiments are doneonanimagewithverylittlevariationinintensity.Atestimagew hereallpixel valueshavingamagnitudeof100iscreated and noise is added to it with the imnoise () function. Denoising is carried out following the techniques discussed in previous secssiona. Signal to Noise Ratio (SNR) for each of these outputs is computed.

Figures 4.1 and 4.2. The SNR of the input and out put images for the filtering approach and wavelet transform approach, respectively.

Table 1. SNR values for filtering approach

METHODS	SNR OUTPUT	NOISE, VARIANCE
Pseudo Inverse Filter	27.43	Salt and Pepper-0.05
Pseudo Inverse Filter	21.24	Gaussian-0.05
Wiener Filter	47.97	Salt and Pepper-0.05
Wiener Filter	22.79	Gaussian-0.05
PROPOSED FILTER	49.67	Salt and Pepper-0.05
PROPOSED FILTER	26.28	Gaussian-0.05
Speckle Remover	42.47	Speckle, 0.4
Speckle Remover	43.54	Speckle, 0.4

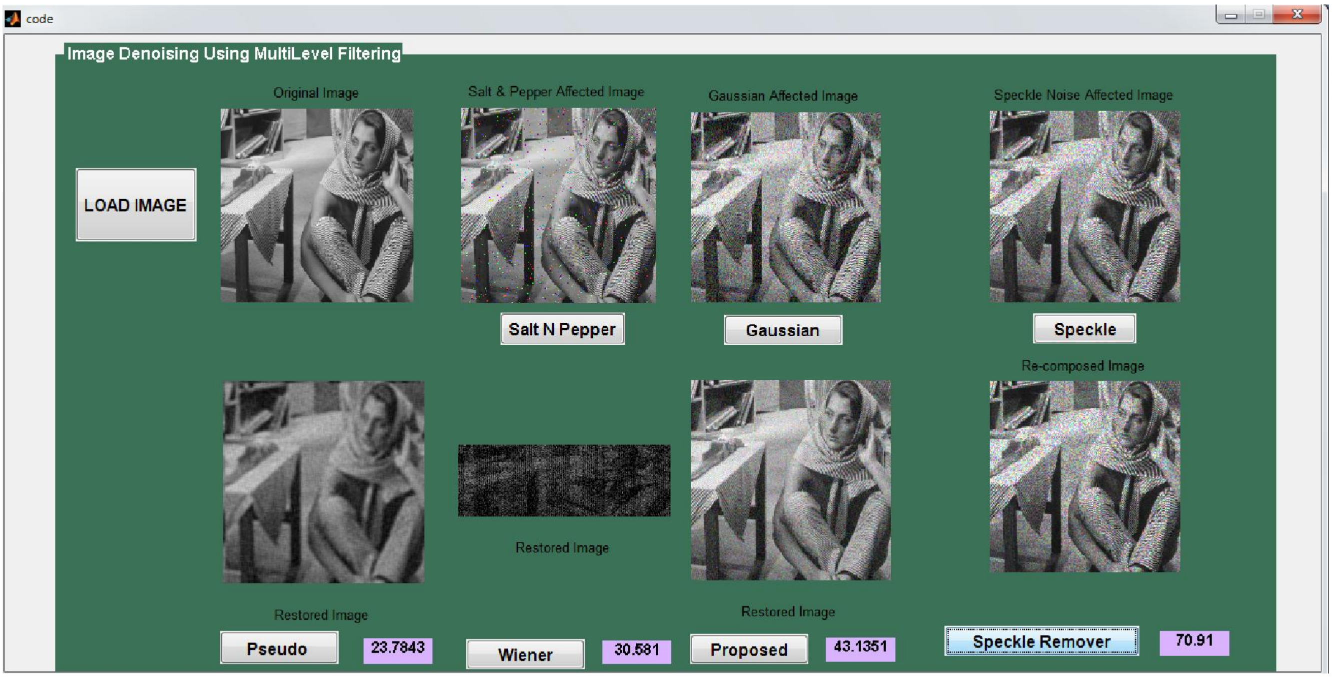

Fig 4.1. Result 1

Fig 4.2 Result 2

From Figures 4.1 and 4.2, it can be seen that the mathematical results obtained from the SNR computation and the experimental results shown in the image outputs in this section only through 5 match closely. For the multi fractal denoising, the SNR computation is not compatible because, the brightness of the output image has been decreased

7. Conclusion

From the experimental and mathematical results it can be concluded that for salt and peppernoise, the median filter is optimal compared to mean filter and LMS adaptive filter. It produces the maximum SNR for the output image compared to the line arfilters considered. The LMS adaptive filter proves to be better than the mean filter but has more time complexity. From the output images shown in section 5, the image obtained from the median filter has no noise present in it and is close to the high quality image. The sharpness of the image is retainedun like in the case of linear filtering. In the case where an image is corrupted with Gaussian noise, the wavelet shrinkage de noising has proved to be nearly optimal. Sure Shrink produces the best SNR compared to Visu Shrink and

Bayes Shrink. However, the output from Bayes Shrink method is much closer to the high quality image and there is no blurring in the output image unlike the other two methods. Visu Shrink cannot de noise multiplicative noise unlike Bayes Shrink. It has been observed that Bayes Shrink is not effective for noise variance higher than 0.05. De noising salt and pepper noise using Visu Shrinkand Bayes Shrink has proved to be inefficient. When the noise characteristics of the image are unknown, de noising by multifractal analysis has proved to be the best method. It does a good job in de noising images that are highly irregular and are corrupted with noise that has a complex nature. In the two methods considered, namely multifractal regularization and multifractal pumping, the second method produces visually high quality images.

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