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Image Denoising using spatial filters and Image Transforms: A Review

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Abstract: An image is a two-dimensional function with a collection of information and is degraded due to the occurrence of noises during image acquisition process, transmission & reception, storage & retrieval processes of the image results in degradation in the visual quality of an image. So the information associated with an image tends to lose or damage. It must be crucial to repair the photograph from noises for obtaining most data from a picture. Picture denoising is a vital pre-processing venture earlier than in addition processing of image like segmentation, feature extraction, texture analysis and so on. The reason of denoising is to get rid of the noise even as retaining the edges and different exact functions as lots as feasible. In this paper, we can see how different types of noise will affect the quality of the images and the information in images. As a remedy, the pleasant and the facts from the noised picture may be retrieved by the use of exclusive styles of filters. On this work gaussian noise, impulsive noise, speckle noise, and poisson noise are being considered and it is able to be decreased using a Gaussian filter, Wiener filter, Mean filter and median filter. The Transforms like wavelets, Contourlet, and curvelet that play the major role in image denoising are also presented. The experimental end result shows the performance of various varieties of filters and transforms to denoise the noised pictures from exclusive sorts of noises.

Index Terms: Gaussian noise, Impulsive noise, Gaussian, Wiener, Mean, Median filter, transforms.

I. INTRODUCTION

Image denoising plays a vital role in digital image processing. There are many schemes for removing noise from images. The good denoising scheme needs to able to retrieve a lot of photograph information despite the fact that the image is fairly tormented by noise [1].In common there are two varieties of picture denoising version, linear model, and a nonlinear model. Normally, a linear version is being considered for image denoising, the main advantages of the use of linear noise putting off models is the speed with a problem of no longer capable of preserve edges of the image in an efficient manner but non-linear models can maintain edges within the images inside the lots better manner than linear models but very slow.In Digital image processing, image acquisition is the creation of digital images.While Creating image because of wrong lens adjustment, images are Degraded. While transmitting the images, Noise which is added to the channel is also degrade the image this degradation of images leads to poor quality. The image degradation model is shown below

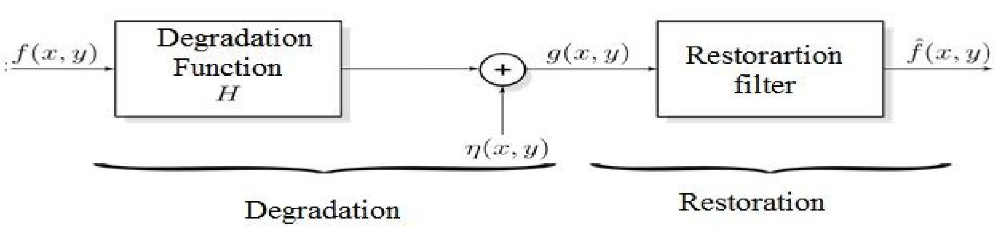


Figure 1: Image Degradation Model

The degraded image in the spatial domain is given by

$$g(x,y) = h(x,y)*f(x,y) + \eta(x,y) \quad (1)$$

where h(x,y) is the spatial representation of the degradation feature and * indicates convolution. In frequency area

$$G(u,v) = H(u,v)F(u,v) + N(u,v) \quad (2)$$

In which N(u,v) is spectrum of noise, H is a linear, position invariant operator. The image restoration process can be obtained by inversing the image degradation process as

$$G(u,v)^{\wedge} = \frac{F(u,v) - N(u,v)}{H(u,v)} = \frac{F(u,v)}{H(u,v)^{\wedge}} \tag{3}$$

II. TYPES OF NOISE MODELS

Noise models are useful in estimation of degradation function. The primary supply of noise in digital images arises throughout image acquisition and /or transmission. The overall performance of imaging sensors is affected by a diffusion of factors, along with environmental situations during picture acquisition and with the aid of the excellent of the sensing elements themselves. Images are corrupted at some stage in transmission principally due to interference in the channels used for transmission. Since essential assets of noise provided in virtual images have resulted from atmospheric disturbance and photo sensor circuitry. Noise degrades the quality of the image.

A. Gaussian Noise

Important assets of gaussian noise in digital photographs get up at some stage in acquisition e.g. sensor noise due to terrible illumination and/or high temperature, and/or transmission. A standard model of photo noise is gaussian, additive, impartial at every pixel, and independent of the signal intensity. PDF of a gaussian random variable z (gray level)

$$p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(z-\mu)^2/2\sigma^2} \tag{4}$$

The special case of gaussian noise is white gaussian noise, wherein the values always are statistically independent. For application cause, gaussian noise is also used as additive white noise to supply additive white gaussian noise.

B. Impulse Noise

An image containing impulsive noise may have dark pixels in white areas and white pixels in dark areas. This sort of noise can be due to analog-to-digital converter problems, bit errors in transmission, and so forth. The PDF of impulse noise is described as

$$p(z) = \begin{cases} p_a & for\ z=a \\ p_b & for\ z=b \\ 0 & otherwise \end{cases} \tag{5}$$

If b>a, the grey stage' b' will seem like a white dot in an image called salt. if a>b, the grey level' a' will seem like a dark dot called pepper in an image. if p_a and p_b are equal then the impulse noise is called unipolar otherwise it's far known as bipolar.

C. Poisson Noise

Poisson noise [2] is likewise called shot noise. It is a sort of digital noise. Poisson noise occurs beneath the situations wherein there's a statistical fluctuation within the dimension precipitated both due to the finite quantity of particles like an electron in an electronic circuit that delivers electricity or by the photons in an optical device. PDF of this noise is given by

$$P(f_{(pi)}=k) = \frac{\lambda^{k}{}_{i} e^{-\lambda}}{k!} \tag{6}$$

D. Speckle Noise

Speckle noise is a form of granular noise that generally exists in and causes degradation in the image best. Speckle noise has a tendency to harm the photo being received from the lively radar in addition to synthetic aperture radar (SAR) images. Because of random fluctuations within the return signal from an object in traditional radar that isn't massive because of the single photograph-processing element, Speckle noise occurs. Speckle noise increases the mean gray degree of a local region. Speckle noise is a more critical problem, causing difficulties for picture interpretation in SAR image. It’s far mainly because of the coherent processing of backscattered signals from more than one dispensed goals.

III. DIFFERENT FILTERS

A. Mean Filter

There are two varieties of filtering schemes particularly linear filtering and nonlinear filtering. Mean clear outcomes underneath linear filtering scheme. Mean filter is likewise called an averaging filter out. The suggest filter applies the mask over every pixel inside the signal. Each of additives of the pixels comes under the masks are being averaged collectively, it is why the clear out is referred to as a median filter. Edge preserving is poor in the mean filter. Mean filter is defined by

$$\hat{f}(x, y) = \frac{1}{mn} \sum_{(s,t)\epsilon S_{xy}} g(s, t) \tag{7}$$

B. Median Filter

The great recognized order-statistic filter is the median filter so that you can replace the value of a pixel by the median of the intensity levels in the neighborhood of that pixel. Median filter arranges the pixels in the given image into ascending or descending order to compute the median. The center pixel is handled as median and it is replaced with center pixel. The expression for the median is

$$\hat{f}(x, y) = \underset{(s,t)}{\text{median}} \tag{8}$$

The median filters can provide good noise-reduction capabilities for certain types of random noise and are effective in the presence of both bipolar and unipolar impulse noise.

C. Wiener Filter

Wiener filtering is called Geometric mean filter. It can be expressed as

$$\hat{F}(u,v) = \left[\frac{H^*(u,v)}{|H(u,v)|}\right]^{\alpha} \left[\frac{H^*(u,v)}{|H(u,v)|^2 + \beta\left[\frac{S_\eta(u,v)}{S_f(u,v)}\right]}\right]^{1-\alpha} G(u,v)$$

with α and β being positive, real constants. (9)

When α=1, the filter acts as the inverse filter. With α=0, it is parametric Wiener filter, which reduces to the standard Wiener filter when β=1. If α=1/2, becomes the product of two filters (with same power), like geometric mean, hence geometric mean filter. When β=1, as α<1/2, the filter more like Wiener filter as α>1/2, the filter more like an inverse filter. When α=1/2 and β=1, the filter is called spectrum equalization filter.

D. Gaussian Filter

The Gaussian filtering scheme is based on the peak detection which is based on the fact that peaks are to be impulses. The main point is that this filter corrects not only the spectral coefficient of interest but all the amplitude spectrum coefficients within the filter window.

IV. DIFFERENT TRANSFORMS

A. Wavelet Transform

Wavelets allow filters to be constructed for Stationary and as well as non-stationary signals. So Wavelet transform is being preferred comparing to other transforms. Wavelet transforms allow both the components of stationary as well as non-stationary signal to be analyzed. Wavelet applications involve image signal processing and filtering. It also includes other area applications

like non-linear regression and compression. More recently, "tree-based" wavelet denoising methods were developed in the context of image denoising, which exploits the tree structure of wavelet coefficients and the so-called parent-child correlations which are present in wavelet coefficients of images with edges. Also, many investigators have experimented with variations on the basic schemes-modifications of thresholding functions, level-dependent thresholding, block thresholding, adaptive choice of threshold, Bayesian conditional expectation nonlinearities, and so on. Extensive efforts by a large number of researchers have produced a body of literature which exhibits substantial progress overall, achieved by combining a sequence of incremental improvements.

B. Contour let Transform

It is widely known that many signal processing obligations, e.g. Compression, denoising, feature extraction and enhancement, gain particularly from having a parsimonious illustration of the sign handy. Do and Vetterli have conceived the Contourlet Transform (CT), which is one in every of several transforms evolved in recent years, aimed at improving the illustration sparsity of photographs over the Wavelet Transform (WT). The major function of these transforms is the capacity to effectively take care of 2-D singularities, i.e. Edges, unlike wavelets that can address point singularities exclusively. This difference is resulting from two main properties that the CT possess: 1) the directionality assets, i.e. Having basis features at many guidelines, as opposed to handiest 3 instructions of wavelets 2) the anisotropy belongings, meaning that the idea capabilities appear at various factor ratios (depending on the scale), while wavelets are separable features and consequently their aspect ratio equals to at least one. The primary advantage of the CT over other geometrically-pushed representations, e.g. Curvelets, is its fairly simple and efficient wavelet-like implementation the usage of iterative filter banks. Due to its structural resemblance to the wavelet transform, many photograph processing duties implemented on wavelets may be seamlessly tailored to contourlets.

C. Curvelet Transform

The curvelet reconstructions display higher sensitivity than the wavelet-based reconstructions. In fact both wavelet reconstructions obscure structure in the hatband which was visually detectable in the noisy panel at upper left. In comparison, every structure in the image which is visually detectable in the noisy image is clearly displayed in the curvelet reconstruction. Curvelets are designed to handle curves using only a small number of coefficients. Hence the Curvelet handles curve discontinuities well.

V. SIMULATION RESULTS

The following result shows images with different noises and corresponding denoising images using filter and Transforms.

Fig2: Original Image

Fig3: Image With Gaussian Noise

Fig4: Gaussian Noise image Filtered by Gaussian Filter

Fig5: Gaussian Noise image Filtered by Mean Filter

Fig6: Gaussian Noise image Filtered by Median Filter

Fig7: Gaussian Noise image Filtered by wiener Filter

Fig8: Image with Impulsive Noise

Fig9: Impulsive noised image filtered by Mean Filter

Fig10: Impulsive noised image filtered by Median Filter

Fig11: Impulsive noised image

Fig12 : Impulsive noised image
Filtered by Wiener Filter

Fig13: Poisson noised image
Filtered by Gaussian Filter

Fig14: Poisson noised image
Filtered by Mean Filter

Fig15: Poisson noised image
Filtered by Median Filter

Fig16: Poisson noised image
Filtered by wiener Filter

Fig17: Poisson noised image
Filtered by Gaussian Filter

Fig18: Speckle noised image

Fig19: Speckle noised image
Filtered by Mean Filter

Fig20: Speckle noised image
Filtered by Median Filter

Fig21: Speckle noised image
Filtered by wiener Filter

Fig22: Speckle noised image
Filtered by Gaussian Filter

Fig23: Denoising by Wavelet Transform

Fig24: Denoising by Contourlet Transform

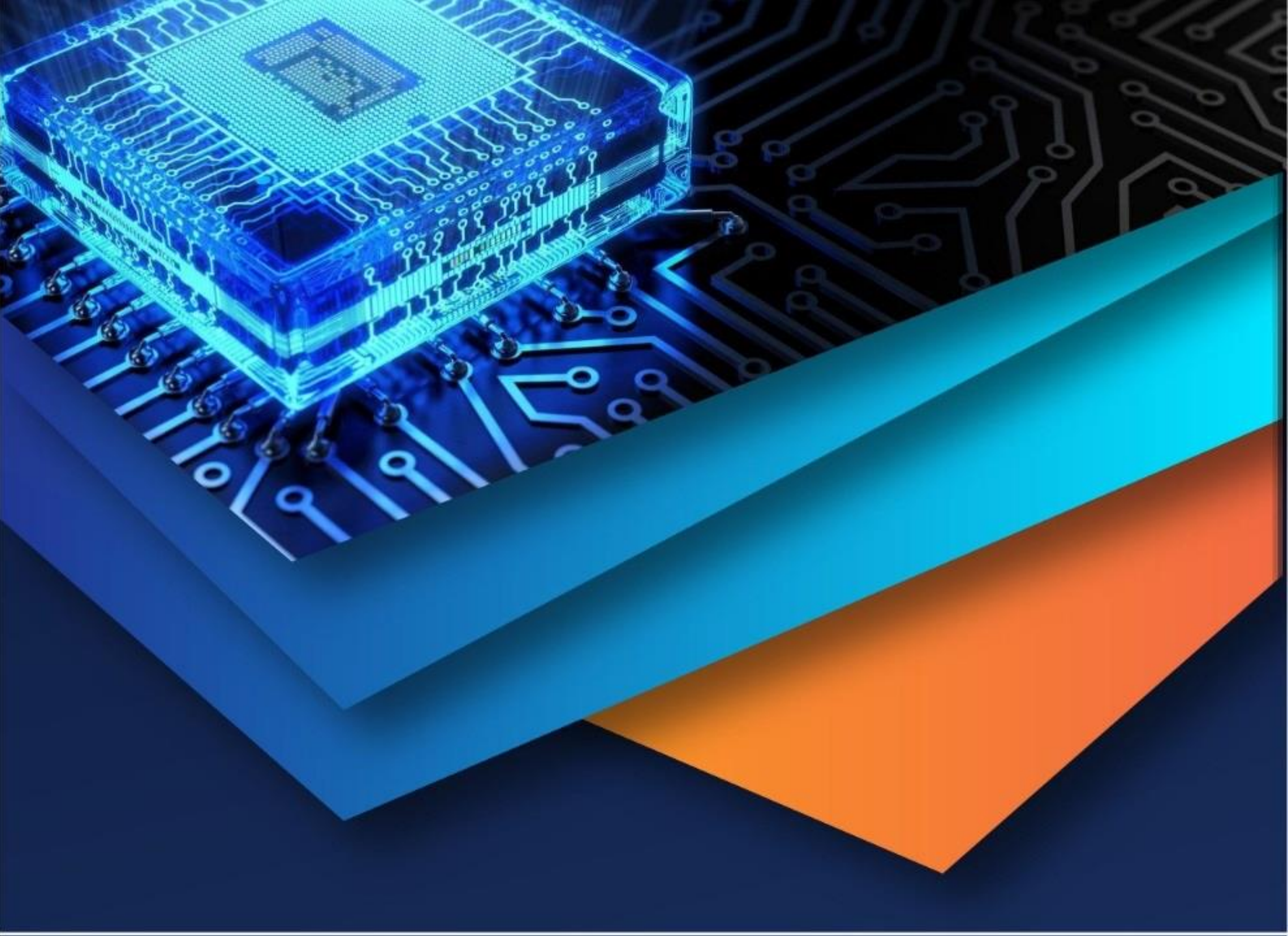
Fig25: Denoising by Curvelet Transform

VI. CONCLUSION

In this paper, four types of noises such as Gaussian, Impulsive Noise, Poisson, and Speckle noise had been added to the original clean 'Lena' image. We observed that all noise causes degradation in the image quality which results in loss of information. The denoising of the degraded image is performed using Mean, Median, Wiener and Gaussian filters. From the simulation results, it is confirmed that Median filter works well for Impulsive noise than Mean, Gaussian, Wiener filter whereas Wiener filter works well for removing Poisson and speckle noise compared to that of Mean and Median filter. Also, Median filter preserves the edges. Denoising of images is also performed using three types of transforms namely wavelet, Contourlet and Curvelet transform. Contourlet is best effective for removing the noise when compared to the transforms specified in this paper with preserving of edges of an image.

REFERENCES

[1] Anandbabu.Gopatoti, Kiran Kumar Gopatoti "Image Denoising Using Contourlet Transform with Total Variation and Nonlocal Similarity Model" International Journal of Pure and Applied Mathematics, Volume 118 No. 18 2018.
[2] Astola, J., Kuosmanen, P., "Fundamentals of Non-linear Digital Filtering", CRC Press, New York, Boca Raton, 1997.
[3] Charles Boncelet, "Image Noise Models" in Alan C.Bovik, Handbook of Image and Video Processing, 2005.
[4] Gajanand Gupta, "Algorithm for Image Processing Using Improved Median Filter and Comparison of Mean, Median and Improved Median Filter" (IJSCE) ISSN: 2231-2307, Volume-1, Issue-5, November 2011.
[5] Gonzalez.R., Woods.R., "Digital Image Processing", 2nd ed. Prentice-Hall, Englewood Cliffs, NJ. 2001.
[6] G.Shi Zhong, "Image De-noising using Wavelet Thresholding and Model Selection", Image Processing, 2000, Proceedings, 2000 International Conference on, Volume: 3, 10-13 Sept. 2000 Pages: 262.
[7] James C. Church, Yixin Chen, and Stephen V.Rice Department of Computer and Information Science, University of Mississippi, "A Spatial Median Filter for Noise Removal in Digital Images", IEEE, page(s): 618- 623, 2008.
[8] M. Rosa-Zurera, A.M. Co´breces-A´lvarez, J.C. Nieto-Borge, M.P. Jarabo-Amores, and D.Mata-Moya. "Wavelet denoising with edge detection for speckle reduction in SAR images" EUSIPCO Poznon, 2007.
[9] P.Y. Chen, C.Y. Lien, "An efficient edge-preserving algorithm for removal of salt-and-pepper noise", IEEE Signal Processing Letters 15, 833–836, 2008.
[10] Sedef Kent, Osman Nuri Oçan, and Tolga Ensari, "Speckle Reduction of Synthetic Aperture Radar Images Using Wavelet Filtering", in Astrium EUSAR 2004 Proceedings, 5th European Conference on Synthetic Aperture Radar, May 25–27, 2004, Ulm, Germany, 2004.



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