International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 8, August - 2014

Image De-Noising Techniques: A Review Paper

Juhi Mishra
M.Tech Scholar
Dept of Electronics & Communication Engineering,
Dr. C.V. Raman University,
Kargi Road, Kota, Bilaspur (C.G.), India

Saurabh Mitra
Assistant Professor
Dept of Electronics & Communication Engineering,
Dr. C.V. Raman University,
Kargi Road, Kota, Bilaspur (C.G.), India

***Abstract*- Image de-noising is an important image processing task, both as a process itself, and as a component in other processes. In today's scenario transmission of information through images has become a major medium of communication. But during transmission of images they get affected by some external means called as noise. The search for effective and efficient image denoising methods is a great challenge for researchers. Different algorithms are available and each algorithm has its assumptions, advantages and limitations. This paper presents a review of some significant work in the field of Image De-noising. The brief introduction of some popular approaches is provided and discussed.**

Keywords- Spatial filtering, linear filtering, non-linear filtering.

I. INTRODUCTION

Digital image processing is rapidly growing field of signal processing. It is concerned basically with extracting important and useful information from an image. Some important fields where image processing is being used are remote sensing, security monitoring, computer tomography, geographical survey etc. the data is collected from image sensors are affected from various types of noises. The main causes of generation of such noises are transmission errors or compression. Therefore there is a need of removal of these noisy errors which is called denoising process. Before processing of any image we must have to remove these noises from image. So for image restoration this would be very first step. Different noise affects the image in destructive manner in various levels. These noises can be categorized in various types like salt and pepper noise i.e. also known as impulse noise, Gaussian noise also called as uniform noise and random noise. Salt and pepper noise includes sparse light and dark disturbances. Pixels in the image are very different in intensity from the other ones. This type of noise will only affect a small number of image pixels. When viewed, the image contains dark and white dots, hence the term salt and pepper noise. This can have value either 0 or 255. Here 0 represents complete black and 255 represent complete white on gray scale image. The random valued impulse noise can have any value between 0 and 255; hence its removal is very important as well as difficult. In Gaussian noise each pixel in the image will be changed from its original value by a small amount. Random noise is a type of noise comprised of transient disturbances which occur at random times; its instantaneous magnitudes are specified only by probability distribution functions which give the fraction of the total time that the magnitude lies within a specified range. In image analysis image de-noising is a very important and essential pre-processing step. It basically recovers the true picture from the degraded one by different algorithms. This pre-processing technique does not affect the quality of image and do not alter any pictorial information. But just like any other process it also has some limitations which are making it a challenging task for researchers. Although it removes noise but also introduces some artifacts and blurring. In this paper different processes for various de-noising methods are being discussed.

This paper is organized as follows. Section II consists of different noise models. In section III a brief description of various techniques for evolution of image de-noising is given. Section IV gives classification and description of various de-noising methods. In section V conclusion for the work is given.

II. NOISE MODEL

Basically noise generated in any image is uncorrelated with image pixels. Impulse noise distribution is random over entire image. These noises can be categorized in Gaussian noise and impulse noise. Unlike Gaussian noise, impulse noise does not affect all pixels of images. Some of them will be noisy and some will be noiseless. In salt and pepper type of noise pixel will either take 255 or 0 values so it appears as white and black spots. So the probability of uncorrupted pixels will be P-1 and noisy pixel will be appeared with the probability P. In case of random valued impulse noise, noise is randomly distributed over the entire image and it can take up any gray level value from 255 to 0.

III. EVOLUTION OF IMAGE DE-NOISING TECHNIQUE

Image de-noising is a fundamental step of image acquisition and processing. Firstly spatial domain approach has been developed. Greatest advantage of such approach was its speed but along with this there was a major drawback i.e. discontinuities in image means it is unable to preserve edges. Then the focus was shifted to Wavelet domain from spatial and Fourier domain. Ever since the Donoho's wavelet based thresholding approach was published in 2003.

Although this approach did not requires tracking and correlation of wavelet maximx and minima across different scales as proposed by Mallat.[3] There was renewed interest in wavelet approach since Donoho's. [4]. Data adaptive threshold were introduced to achieve optimum threshold[6]. Translation invariant method can improve the quality of perception. More researches were Gaussian scale mixtures, hidden markovo models also Bayesian de-noising. Different statistical models are focused to model the statistical properties of wavelet coefficients and its neighbors. Future trend will be to find more probabilistic model for non-orthogonal wavelet coefficients distribution.

IV. NOISE CLASSIFICATION

For image de-noising two basic methods are popular termed as special filtering method and transform domain filtering method.

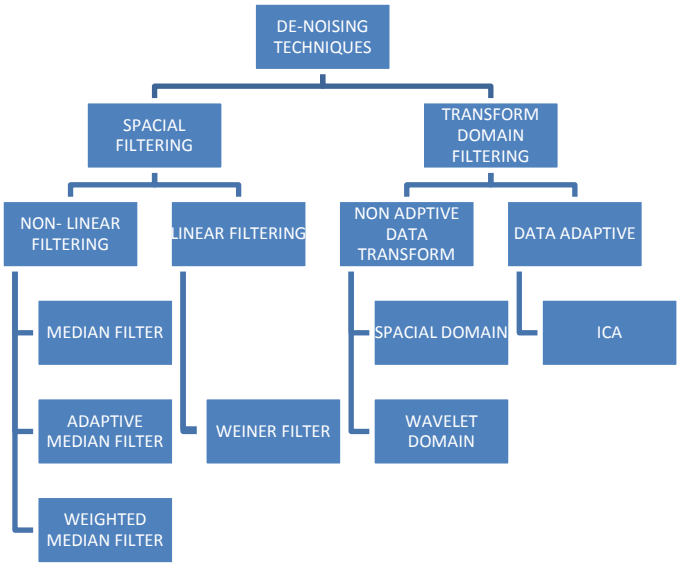

Figure 1. classification of image de-noising

4.1. Spacial Filtering-

It is specially used for image enhancement. It performs many tasks like image sharpening etc. it works on neighboring pixels and filtered image pixels are assigned to a corresponding location in a new image. Spatial filters are further classified as non-linear and linear filters.

4.1.1. Non-Linear Filters-

Special filters employ a low pass filtering on groups of pixels with an assumption that noise occupies the higher frequency region of the spectrum. Special filters remove noise from an image in considerable level but it generates various unwanted effect like blurring in image. Various types of special filters are available here like median filter, adaptive median filter etc.

(A). Median Filter-

It considers each pixel in image in turn and looks at its nearby neighbor to decide whether or not it is representative of its surrounding. It replaces the pixel's present value with median of neighbor pixel values.

(B). Adaptive Median Filter-

It performs special processing to determine which pixels in an image have been affected by noise. It classifies pixels as noise by comparing each pixel in image to its surrounding neighbor pixels. The size of neighborhood is adjustable. A pixel that is different from majority of its neighborhood as well as not structurally aligned with those pixels are then replaced by median pixel values of pixels.

(C). Weighted Median Filter-

Centre median filter is easy to implement, it gives more weight to some values within the window. One most important type of weighted filter is centre weighted median filter which gives more weight to the central value of the window.

4.1.2 Linear Filter-

Linear filters are generally of two types: mean filter and wiener filter. These filters execute poorly in presence of noise, which results in form of loss of image information.

(A). Mean Filter-

Mean filter is a simple sliding window special filter which replaces the value of central window with the average value of all nearby pixel itself. It is implemented with the convolution mask, generally 3×3 mask is used.

(B) Weiner Filter-

Weiner filtering requires the information on the spectra of noise and original signal it works better when the signal is smooth. To overcome such problems wavelet based denoising techniques are being used.

4.2. Transform Domain

Transform domain can be classified depending on the function. It can be further subdivided into non adaptive data transform and adaptive data transform.

4.2.1. Non Adaptive Data Transform

(A). Spatial Frequency Filter

It uses a low pass filter with fast fourier transform. Here we have to assign a cut-off frequency to the filter when the noise is decorrelated with useful signal. Drawback of such transform method is that they are time consuming and dependent on cut-off frequency. Also this may cause artificial frequency in new processed images.

(B). Wavelet Domain-

Wavelet Domain process is again subdivided into two distinct techniques i.e. linear and non-linear techniques:

(a). Linear Filter

If the signal corruption can be modelled as gaussian process, Linear filters such as Weiner filter can give the optimal result and mean square error (MSE) is the accuracy criterion. Wiener filtering is used where data corruption can be modeled as a Gaussian process and accuracy criterion is mean square error. However, if we design a filter on this assumption, this results in a filtered image which is very displeasant than the original noisy signal even though it considerably reduces the MSE. In a wavelet domain spatially adaptive Weiner Filtering is proposed in which intrascale filtering is not allowed in any case.

(b). Non-Linear Threshold Filtering

Non-Linear threshold filtering is the most investigated domain in denoising using wavelet transform. It basically uses the property of wavelet transform and the fact that wavelet transform maps noise in signal domain to that of noise in transform domain. Thus while signal energy becomes more concentrated into fewer coefficients in transform domain noise energy does not. The method where small coefficients are removed leaving other coefficients untouched is known as Hard Thresholding. However this method produces spurious blips known as artifacts. To overcome these demerits soft thresholding was introduced where coefficients above the threshold are shrunk by the absolute value of threshold itself.

4.2.2. Independent Component Analysis (Ica)-

Under the category of data adaptive transformation independent component analysis (ICA) is most widely used technique for finding or extracting individual signal from mixtures. Main application of ICA is in blind source separation. It is also helpful for denoising of gaussian and non-gaussian distribution. Because it uses sliding window method, its cost of computation is very high. Also it requires samples which are free of noise but it is difficult to find in some applications.

V. CONCLUSION

This paper reviews the existing denoising algorithms, such as filtering approach; wavelet based approach. Different noise models including additive and multiplicative types are used. They include Gaussian noise, salt and pepper noise, speckle noise and Brownian noise. The filtering approach seems to be a better choice when the image is corrupted with salt and pepper noise. The wavelet based approach finds applications in denoising images corrupted with Gaussian noise. Selection of the denoising algorithm is application dependent. Hence, it is necessary to have knowledge about the noise present in the image so as to select the appropriate denoising algorithm.

VI. REFERENCES

[1]. Anestis Antoniadis, Jeremie Bigot, "Wavelet Estimators in Nonparametric Regression: A Comparative Simulation Study," *Journal of Statistical Software*, Vol 6, I 06, 2001.
[2]. Castleman Kenneth R, *Digital Image Processing*, Prentice Hall, New Jersey, 1979.
[3]. S. Grace Chang, Bin Yu and Martin Vetterli, "Adaptive Wavelet Thresholding for Image Denoising and Compression," *IEEE Trans. Image Processing*, Vol 9, No. 9, Sept 2000, pg 1532-1546.
[4]. David L. Donoho, "De-noising by soft-thresholding," http://citeseer.nj.nec.com/cache/papers/cs/2831/http:zSzzSzwwwstat . stanford.eduSzreportszSzdonohozSzdenoiserelease3.pdf/donoho94 de noising.pdf, Dept of Statistics, Stanford University, 1992.
[5]. David L. Donoho and Iain M. Johnstone, "Adapting to Unknown Smoothness via Wavelet Shrinkage," *Journal of American Statistical Association*, 90(432):1200-1224, December 1995.
[6]. 1/*f* noise, "Brownian Noise," http://classes.yale.edu/99-00/math190a/OneOverF.html, 1999.
[7]. B.M.Gammel, "Multifractals," http://www1.physik.tumuenchen. de/~gammel/matpack/html/Mathematics/Multifractals.html, September 1996.
[8]. Langis Gagnon, "Wavelet Filtering of Speckle Noise-Some Numerical Results," *Proceedings of the Conference Vision Interface* 1999, Trois- Riveres.
[9]. Amara Graps, "An Introduction to Wavelets," *IEEE Computational Science and Engineering*, summer 1995, Vol 2, No. 2.
[10]. David Harte, *Multifractals Theory and applications*, Chapman and Hall/CRC, New York, 2001.
[11]. Matlab 6.1, "Image Processing Toolbox," http://www.mathworks.com/access/helpdesk/help/toolbox/images/images. shtml

[12]. Reginald L. Lagendijk, Jan Biemond, *Iterative Identification and Restoration of Images*, Kulwer Academic, Boston, 1991.
[13]. J.N. Lin, X. Nie, and R. Unbehauen, "Two-Dimensional LMS Adaptive Filter Incorporating a Local-Mean Estimator for Image Processing," *IEEE Transactions on Circuits and Systems-II: Analog and Digital Signal Processing*, Vol 40, No.7 July 1993, pg. 417-428.
[14]. Jacques Lèvy Vèhel and Evelyne Lutton, "Evolutionary signal enhancement based on Hölder regularity analysis," *Project Fractales- INRIA*, 2001.
[15]. Mandelbrot, B., and Wallis, J., "Noah, Joseph and operational hydrology," *Water Resources Research* 4, 909-918, 1968.
[16]. Mallat S.G, "A theory for multiresolution signal decomposition: The wavelet representation," *IEEE Trans. Pattn Anal. Mach. Intell*., 11, 674- 693, 1989.
[17]. Peter R. Massopust, *Fractal Functions, Fractal Surfaces, and Wavelets*, Academic press, San Diego, 1994.
[18]. Matlab6.1, "Matlab," http://www.mathworks.com/, May 2001.
[19]. Wayne Niblack, *An Introduction to Digital Image Processing*, Prentice Hall, New Jersey, 1986.
[20]. Rudolf H. Riedi, "Multifractals and Wavelets: A potential tool in Geophysics," *SEG Expanded Abstracts*, Rice University, Houston, Texas, 1998.
[21]. Image Processing Fundamentals-Statistics, "Signal to Noise ratio," http://www.ph.tn.tudelft.nl/courses/FIP/noframes/fip-Statisti.html, 2001.
[22]. Carl Taswell, "The What, How, and Why of Wavelet Shrinkage Denoising,", http://www.toolsmiths.com/docs/CT199809.pdf, *Technical Report*, Stanford, CA, 1999.
[23]. Tim Edwards, "Discrete Wavelet Transforms: Theory and Implementation," *Discrete Wavelet Transforms*, Stanford University, Draft #2, June 4, 1992
[24]. S. Theodoridis and K. Koutroumbas, *Pattern Recognition*, Academic Press, San Diego, CA, 1999.
[25]. Scott E Umbaugh, *Computer Vision and Image Processing*, Prentice Hall PTR, New Jersey, 1998.
[26]. Jacques Lèvy Vèhel, Bertrand Guiheneuf, "Multifractal image denoising," *Project Fractales-INRIA*, April, 1997.
[27]. Jacques Lèvy Vèhel, "Signal Enhancement Based on Hölder Regularity Analysis," *Project Fractales-INRIA*, 2001.
[28]. Jacques Lévy Véhel, "Fraclab," www-rocq.inria.fr/fractales/, May 2000
[29]. B. Vidakovic, *Statistical modeling by wavelets*, John Wiley and Sons, Inc. New York, 1999.
[30]. Matlab 6.1, "Wavelet tool box," http://www.mathworks.com/access/helpdesk/help/toolbox/wavelet/wavelet .shtml