An Extensive Literature Review on Image De-Noising Techniques

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Abstract— Removal of noise is an important step in the image restoration process, but denoising of image remains a challenging problem in recent research associate with image processing. Denoising is used to remove the noise from corrupted image, while retaining the edges and other detailed features as much as possible. This noise gets introduced during acquisition, transmission & reception and storage & retrieval processes. To find out denoising image the modified denoising method and the local adaptive wavelet image denoising method is used. In this review paper research studies have been analyzed in order to enhance the system performance of Image denoising system .

Keywords: RMSE, PSNR, Wavelet Transform.

I. INTRODUCTION

Digital images play an important role both in daily life applications such as satellite television, computer tomography as well as in areas of research and technology such as geographical information systems and astronomy. In reality, an image is mixed with certain amount of noise which decreases visual quality of image. Therefore, removal of noise in an image is a very common problem in recent research in image processing. An image gets corrupted with noise during acquisition or at transmission due to channel errors or in storage media due to faulty hardware. Removing noise from the noisy image is still a challenging problem for researchers.

Noise may be classified as substitutive noise (impulsive noise: e.g., salt and pepper noise, random valued impulse noise, etc.), additive noise (e.g., additive white Gaussian noise) and multiplicative noise (e.g. speckle noise). In general, the goal of any noise removal scheme is to suppress noise as well as to preserve details and edges of image as much as possible.

Removal of noise is an important in the image processing. Fig. 1 shows the basic model for denoising of image. In the implementation of these methods, first the noisy image is decomposed by wavelet transform. After this, by using thresholding shrink decomposed images and apply adaptive wiener filter to decomposed images. Finally denoised image is obtained by using inverse wavelet transform as shown in fig.1.

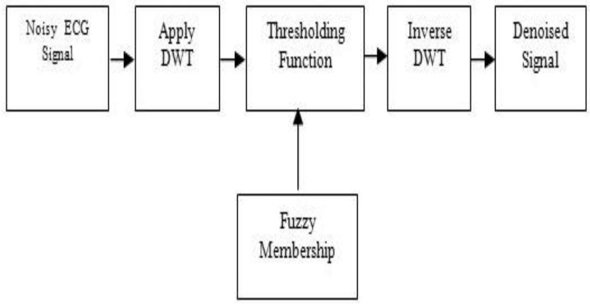

Fig.1 Basic Model for Denoising of Image.

Image denoising is a kind of processing of image which belongs to image restoration, and the ultimate goal of restoration techniques is to improve an image in some predefined sense. Images were degraded in the processes of acquisition, transmission and storage, and it affects the conclusions of observation, even disturbs the understanding and recognition of image, so denoising is the key step of image processing and recognition.

Wiener filtering method is a most usual method for image denoising. There are lots of improved algorithms of Wiener filtering in recent years, wiener filters for the restoration of blurred images a new denoised method that is Region-of-interest reconstruction from noisy projections using fractal models and Wiener filtering; Spatial image filtering based on wavelet thresholding denoising Image via best wavelet packet base using Wiener cost function, but the denoising results can't satisfy the requirement of image recognition and analysis because the noise various.

When the model of noise corruption is assumed additive Gaussian as it often is, it lends to well-founded techniques such as Wiener filtering and wavelet shrinkage methods. Though termed as the standard method, the Wiener filter falls short in most of the image denoising applications because of its linearity and the fact that image data are rather sparsely distributed. Wavelet transform converts the image into another domain where noise is more tractable. Many new techniques based on wavelet-transform are generally superior to the classical Wiener filtering. However setting shrinkage threshold remains a critical and difficult issue.

Independent component analysis (ICA) opens up a new paradigm for signal processing. ICA is a technique that recovers a set of independent source signals from a set of observed, mixed signals without a priori knowledge of the sources, thus is also termed as blind source separation (BSS). It is assumed that each measured signal is a linear combination of the independent original signals. Furthermore it is assumed that the sources are nongaussian. For this reason, a nongaussianity measure is chosen to direct and evaluate the separation of the independent sources. Different from previous ICA based denoising approaches. The technique exploits the nongaussianity of the processed image for finding of the optimal thresholds for wavelet coefficients. In the following sections, the basic theory and implementation of the method will be explained, which is then compared with a few wavelet-based shrinkage methods as well as the classical Wiener filtering technique.

II. DISCRETE WAVELET TRANSFORM

Wavelets are the mathematical functions which analyze data according to the scale or resolution. They help in studying a signal in different windows or in different resolutions. For example, if the signal is viewed in the large window, gross feature can be noticed, and if viewed in a small window, only the small features can be noticed. The wavelets provide some advantages over Fourier transforms. For instance, they do a great job in approximating signals with sharp spikes and signals having discontinuities. Wavelets can also model music, speech, video and non-stationary stochastic signals. The wavelets can be used in applications such as turbulence, image compression, human vision, earthquake prediction, etc. The term “wavelets” is referred to a set of orthonormal basis functions generated by translation and dilation of scaling function φ and a mother wavelet φ. A finite scale multi resolution representation of a discrete function is called as a discrete wavelet transform. DWT is a fast linear operation on the data vector, whose length is an integral power of two. This transform is orthogonal and invertible where the inverse transform expressed as the matrix is the transpose of the transform matrix. The wavelet basis or function, unlike sines and cosines in Fourier transform, is localized in space. Similar to sines and cosines the individual wavelet functions are localized in frequency.

The orthonormal basis or wavelet basis is defined as:

$$\psi_{(j,k)}(x) = 2^{j/2}\psi(2^j x - k)$$

The scaling function is given as

$$\phi_{(j,k)}(x) = 2^{j/2}\phi(2^j x - k)$$

Where ψ is the wavelet function and j and k are integers that scale and dilate the wavelet function. Factor ‘j’ in Equations is called as the scale index, which indicates the width of the wavelet. The location index k provides the position. The wavelet function is dilated by powers of two and is translated by the integer k. In terms of the wavelet coefficients, the wavelet equation is

$$\psi(x) = \sum_{k}^{N-1} g_k \sqrt{2\phi(2x - k)}$$

Where g0, g1, g2…. are high pass wavelet coefficients. The scaling equation in terms of scaling coefficients as given below

$$\phi(x) = \sum_{k}^{N-1} h_k \sqrt{2\phi(2x - k)}$$

The function $\phi(x)$ is the scaling function and the coefficients h0, h1,….. are low pass scaling coefficients. The wavelet and scaling coefficients are related by the quadrature mirror relationship, which is

$$g_n = (-1)^n\, h_{1-n} + N$$

Where N is the number of vanishing moments.

III. LITERATURE SURVEY

Kethwas and B. Jharia, [1] nowadays images are very fundamental type data for transmission. In this paper, a mixed domain image denoising method based on the wavelet transform median filter and nonlinear diffusion are proposed. The wavelet transform is used to convert the spatial domain image to wavelet domain coefficients. Wavelet transform produces approximation, horizontal, vertical and diagonal detailed coefficient which represents the various spatial frequency bands. These coefficients may be filtered by wiener filter or fuzzy filter separately. One is based on median and moving average, while other one used on probabilistic way, respectively. Paper presents the two different techniques for image denoising, first technique is ATMAV (Asymmetrical Triangular Moving Average Filter) with HAAR wavelet transform and second is ATMED (Asymmetrical Triangular Median Filter) with HAAR wavelet transform. Both techniques are based on fuzzy logic based filters. Comparative analytical study based on PSNR and mean square error shows that HAAR with ATMED wavelet is better technique for image denoising.

Li Ke, Weiqi Yuan and Yang Xiao, [2] In order to denoise image and improve its visual quality, an improved Wiener filtering method is proposed based on wavelet transform. First, image noise is analyzed, and then the image corrupted by noise is given. The noisy image is denoised by the improved Wiener filtering method based on wavelet transform. The procession is repeated until the denoised image satisfied the requirements. Experiment results demonstrate that the new method removes the noise of image and improves the image visual quality, with the PSNR between the denoised image and the original image is increased by 2.02, while PSNR between the denoised image and the noisy image is similar to the PSNR between the noisy image and original image. It can get the conclusion that the method denoised image with good visual effect, and it is an effective image processing method.

Sr. No.	Title	Authors	Year	Methodology
1	Image de-noising using fuzzy and wiener filter in wavelet domain	A. Kethwas and B. Jharia	2015	Proposed a mixed domain image denoising method based on the wavelet transform median filter and nonlinear diffusion are proposed. The wavelet transform is used to convert the spatial domain image to wavelet domain coefficients.
2	An improved Wiener filtering method in wavelet domain	Li Ke, Weiqi Yuan and Yang Xiao	2008	An improved Wiener filtering method is proposed based on wavelet transform. First, image noise is analyzed, and then the image corrupted by noise is given.
3	Performance evaluation and comparison of modified denoising method and the local adaptive wavelet image denoising method	J. M. Parmar and S. A. Patil	2013	In this study presents To find out denoised image the modified denoising method and the local adaptive wavelet image denoising method can be used.
4	Median filtering using fuzzy concept	H. K. Kwan and Y. Cai	1993	Two nonlinear filters, called fuzzy median filters are introduced.
5	A novel wavelet thresholding method for adaptive image denoising	I. Hussain and Hujun Yin	2008	Presents a novel wavelet-based shrinkage technique in conjunction with the nongaussianity measure for image denoising.

J. M. Parmar and S. A. Patil, [3] Removal of noise is an important step in the image restoration process, but denoising of image remains a challenging problem in recent research associate with image processing. Denoising is used to remove the noise from corrupted image, while retaining the edges and other detailed features as much as possible. This noise gets introduced during acquisition, transmission & reception and storage & retrieval processes. In this paper, to find out denoised image the modified denoising method and the local adaptive wavelet image denoising method can be used. The noisy image is denoised by modified denoising method which is based on wavelet domain and spatial domain and the local adaptive wavelet image denoising method which is based on wavelet domain. In this paper, authors have evaluated and compared performances of modified denoising method and the local adaptive wavelet image denoising method. These methods are compared with other based on PSNR (Peak signal to noise ratio) between original image and noisy image and PSNR between original image and denoised image. Simulation and experiment results for an image demonstrate that RMSE of the local adaptive wavelet image denoising method is least as compare to modified denoising method and the PSNR of the local adaptive wavelet image denoising method is high than other method. Therefore, the image after denoising has a better visual effect. In this paper, these two methods are implemented by using MATLAB for denoising of image.

H. K. Kwan and Y. Cai, [4] Two nonlinear filters, called fuzzy median filters are introduced. Preliminary simulation results based on a periodic rectangular signal contaminated with random noise, impulse noise, and addition of random and impulse noises indicate that the two fuzzy median filters are suitable for the edge preservation of a signal.

I. Hussain and Hujun Yin, [5] in this work they present a novel wavelet-based shrinkage technique in conjunction with the nongaussianity measure for image denoising. It provides an adaptive way of setting optimal threshold for wavelet shrinkage schemes, which have in the last decade been shown to yield promising and superior performance than classical methods such as Wiener filtering. Selection of a precise threshold has always remained a difficult issue and is largely done empirically and many methods consider using a universal threshold, which is known to produce over smoothed images. The proposed method selects the threshold adaptively based on image data and leads to improved results. The method makes use of the nongaussianity of the processed image as the performance measure for selection of a particular threshold. Experimental results are provided, together with comparisons with both Wiener filtering and existing wavelet shrinkage schemes.

IV. PROBLEM IDENTIFICATION

The denoising of image is initial step in image processing. Robustness and detail preservation are the two most important aspects of modem image enhancement filters. There are several methods for image denoising in spatial and transform domain. The current trends of the image denoising research are the evolution of mixed domain methods. Based on the result, it is clear that ATMAV with HAAR gives result for image denoising, while HAAR with ATMED wavelet gives better result as compared to previous techniques. To get better denoising effects using fuzzy filters.

V. CONCLUSION

The field of image processing focuses on automating the process of gathering and processing visual information. The process of receiving and analyzing visual information by digital computer is called digital image processing. It usually refers to the processing of a 2-dimensional picture signal by a digital hardware. Image enhancement is subjective area of image processing. These techniques are used to highlight certain features of interest in an image. Two important examples of image enhancement are: (i) increasing the contrast, and (ii) changing the brightness level of an image so that the image looks better.

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