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A Literature Survey on Image Denoising Techniques

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ABSTRACT: This paper addresses the problem of image denoising which is still a valid challenge. An image is often corrupted by noise in its acquisition, production and transmission. In order to improve the quality and visual perception of an image noise must be removed and the important features like edge details should be retained as much as possible. In this paper we studied and analyzed different image denoising methods. The main aim of this survey is to provide evolution of research in the field of image denoising & improvement of the denoising algorithm. During survey of work we have found that different authors have developed different methods to solve the purpose. So we conclude that there is not any unique method in this regard. Performance of de-noising algorithm is measured using quantitative performance measures such as Signal-to-Noise Ratio (SNR) and Mean Square Error (MSE). So, in this paper, we come across to develop a conclusion of effective algorithm for removing Impulsive noise.

KEYWORDS: Wavelet transforms, SNR, MSE, PSNR, PURE-LET and MRBF.

I. INTRODUCTION

During acquisition and transmission, images are inevitably contaminated by noise. As an essential and important step to improve the accuracy of the possible subsequent processing, image denoising is highly desirable for numerous applications, such as visual enhancement, feature extraction, and object recognition. The purpose of denoising is to reconstruct the original image from its noisy observation as accurately as possible, while preserving important detail features such as edges and textures in the denoised image. To achieve this goal, over the past several decades, image denoising has been extensively studied in the signal processing community, and numerous denoising techniques have been proposed in the literature. In general, denoising algorithms can be roughly classified into three categories: 1) spatial domain methods; 2) transform domain methods; and 3) hybrid methods. The first class utilizes the spatial correlation of pixels to smooth the noisy image, the second one exploits the sparsity of representation coefficients of the signal to distinguish the signal and noise, and the third one takes advantage of spatial correlation and sparse representation to suppress noise[1].

Image denoising is very important on guaranteeing the effectiveness and robustness of other image processing algorithms in the industry image process procedures, such as image registration, image segmentation [4]. The removing of noise from any affected image is referred as denoising. The goal of denoising is to remove the noise and to retain the important image features as much as possible. There are many filters that are used as an initial action before post-processing (i.e. image segmentation) by taking neighboring pixels into consideration which extremely 'noisy' pixels that could be filtered out. Recently many challenges have been made to reduce the noise from images using wavelet transform as a multi-resolution image processing tool [6].

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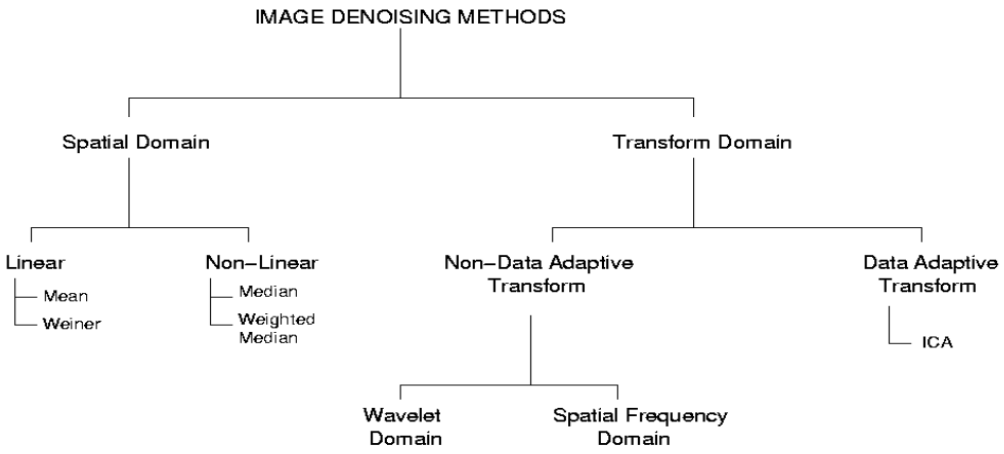

Figure 1: Classification of Image Denoising Methods

In the past few years, several researches are performed in the image denoising by a huge number of researchers. In this paper, we present a comprehensive review of extremely important researches on image denoising together with compression. The popular literature existing in the image denoising is categorized and reviewed comprehensively.

II. PRELIMINARIES

Spatial Filtering operations that are performed directly on the pixels of an image is referred as spatial filtering. Spatial filters can be further classified into non-linear and linear filters.

In wavelet domain, the noise is uniformly spread throughout the coefficients, while most of the image information is concentrated in the few largest coefficients. In DWT an image is filtered into four sub bands at each resolution and the sub band which has lowest frequency sub band is further subdivided through an iterative process to provide the multi resolution representation. When an image is decomposed using wavelet transform, the four sub images are produced and find appropriate value (threshold) which separates noise values to actual image values without affecting the significant features of the image by using the obtained thresholding value denoise the image either by hard thresholding and soft thresholding [7].

The aim of an image-denoising algorithm is then to reduce the noise level, while preserving the image features. All digital images contain some degree of noise due to the corruption in its acquisition and transmission by various effects. Because the wavelet transform has an ability to capture the energy of a signal in few energy transform values, the wavelet denoising technique is very effective. When an image is decomposed using wavelet transform, the four sub images are produced and by using the obtained thresholding value denoise the image either by hard thresholding and soft thresholding.

III. RELATED WORK

Lingli Huang et.al [4] has proposed: "Improved Non-Local Means Algorithm for Image Denoising" Image denoising technology is one of the forelands in the field of computer graphic and computer Vision. Non-local means method is one of the great performing methods which arouse tremendous research. In this paper, author's proposed an improved weighted non-local means algorithm for image denoising. The non-local means denoising method replaces each pixel by the weighted average of pixels with the surrounding neighborhoods. The proposed method evaluates on testing images with various levels noise. Experimental results show that the algorithm improves the denoising performance.

Haijuan Hu et.al [5] has proposed "Removing Mixture of Gaussian and Impulse Noise By Patch-Based Weighted Means". Authors firstly establish a law of large numbers and a convergence theorem in distribution to show

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the rate of convergence of the non-local means filter for removing Gaussian noise. After that introduce the notion of degree of similarity to measure the role of similarity for the non-local means filter. Based on the convergence theorems, authors propose a patch-based weighted means filter for removing impulse noise and its mixture with Gaussian noise by combining the essential idea of the trilateral filter and that of the non-local means filter. Experiments results show that author's proposed filter is competitive compared to recently proposed methods.

Jaiswal A. [6] has proposed "Image Denoising and Quality Measurements By Using Filtering And Wavelet Based Techniques". In this paper authors have worked with denoising of salt–pepper and Gaussian noise. The work is organized in four steps as follows: (1) image is denoised by filtering method, (2) image is denoised by wavelet based techniques using thresholding, (3) hard thresholding and filtering method applied simultaneously on noisy image, (4) results of PSNR (peak signal to noise ratio) and MSE (mean square error) are calculated by comparing all cases.

Zeinab et.al [7] presented: "Multi Resolution Bilateral Filter for MR Image Denoising". In this paper authors proposed an extension of the bilateral filter: multi resolution bilateral filter (MRBF), wavelet transform (WT) sub-bands mixing. The proposed wavelet sub-bands mixing is based on a multi resolution approach for improving the quality of image denoising filter, which turns out to be very effective in eliminating noise in noisy images. Quantitative validation was carried out on synthetic datasets generated with the Brain Web simulator. Comparison with other methods, such as nonlinear diffusion, Fourth-Order Partial Differential Equations , Total variation, Nonlocal mean, Wavelet thresholding, and Bilateral filters , shows that the proposed multi resolution bilateral filter (MRBF) provides better denoising results.

Yong-Hwan Lee et.al [8] has presented: "Wavelet-based Image Denoising with Optimal Filter". In this paper authors presented Image denoising is basic work for image processing, analysis and computer vision. This paper proposes a novel algorithm based on wavelet threshold for image denoising, which is combined with the linear CLS (Constrained Least Squares) filtering and thresholding methods in the transform domain.

Caroline Chaux et.al presented [9] has presented "Image Analysis Using a Dual-Tree M-Band Wavelet Transform" and proposed a 2D generalization to the M-band case of the dual-tree decomposition structure (initially proposed by N. Kingsbury and further investigated by I. Selesnick) based on a Hilbert pair of wavelets. Authors propose a new optimal signal reconstruction technique, which minimizes potential estimation errors.

Hossein Talebi, Student Member, IEEE, and Peyman Milanfar, Fellow, IEEE [10] has presented: Authors addressed these shortcomings by developing a paradigm for truly global filtering where each pixel is estimated from all pixels in the image. Author's objectives in this paper are two-fold. First, to give a statistical analysis of their proposed global filter, based on a spectral decomposition of its corresponding operator, and study the effect of truncation of this spectral decomposition. Second,to derive an approximation to the spectral components using the Nyström extension. Using these, authors demonstrate that this global filter can be implemented efficiently by sampling a fairly small percentage of the pixels in the image.5

IV. DISCUSSION

After studying different approaches we observe that some of the approach provides good denoising for image, but still there is need of an approach which may provide better agreement of result. PSNR indicates the high quality of image and PSNR is defined via the Mean Square Error (MSE).MSE are needed for the calculation of PSNR value for example when to compute the **MSE** between two identical images, the value will be zero and hence the **PSNR** will be undefined (division by zero). So MSE is needed only to calculate the value of PSNR when the value of **MSE** is approaches to zero **PSNR** will be increases.

V. FUTURE WORK & CHALLENGES

After analyzing several techniques we proposed an approach to denoise image. Combined modified median weighted filter with thresholding based wavelet transform approach is proposed to apply on noisy image and expecting for betterment of result.

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VI. CONCLUSION

In this paper we present a survey on image denoising. Concentrating on different denoising techniques and emphasize on the problems, we also suggest an efficient solution to solve the above problem.

A large number of linear and non linear filtering algorithms have been developed to reduce noise from corrupted images to enhance visual quality. The most common type of noise is the Impulsive noise. Linear filtering is efficient technique to deal with additive noise while non-linear filters are efficient to deal with the multiplicative and function based noise. A novel and effective algorithm for removing Impulsive noise is proposed. If we are moving to the thresholding based wavelet transform provides better de-noising while preserving the details of image like edges. PSNR and MSE are the performance parameters.

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