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Image Denoising Techniques and Applications: Survey and Discussions

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ABSTRACT
The ultimate goal of image denoising from video is to improve the given image, which can reduce noise interference to ensure image quality. Through denoising technology, image quality can have effectively optimized, signal-to-noise ratio can have increased, and the original mage information can have better reflected. As an important preprocessing method, people have made extensive research on image denoising algorithm. Image denoising algorithm has received considerable attention in various fields. Most of the conventional filtering techniques, such as mean filter, Gaussian filter and minimum mean squared error filter, cannot always guarantee the acceptable quality of denoised image with the high peak signal noise ratio (PSNR) and so on. In recent decades, the discrete Wavelet transform (DWT) has been applied to dispose the problem of noise reduction, and it has been shown to be outperformed to traditional filters in terms of root mean squared error (RMSE), PSNR and other evaluation indicators. In this paper we review the image denoising techniques and their applications.

Keywords:- Image denoising, signal-to-noise ratio, Total variation, Object recognition, Image processing.

INRODUCTION
Image denoising is a vital preprocessing step for image based object detection, recognition, and tracking Since high frequency image details are mixed with noise in most cases, most of the existing image denoising methods have difficult preserving the edge and texture information while thoroughly eliminating the noise [8]. Many traditional image processing methods are exploited on the basis of the local structural regularity assumption present in natural images. The rationale of denoising algorithms is to make use of the structural patterns to regularize the ill-posed restoration problem and make the texture region less blurry and the flat region smoother. The gradient based total variation (TV) is a state-of-the-art method that has been proven to restore real scenes from noisy images effectively. However, the TV model tends to introduce staircase effect and texture loss. To surmount the inherent defects of TV regularization, some improved TV models with structure preserving performance are presented. By combining intensity into the definition of the distance between pixels, bilateral filtering clearly relieves the blurring effect of the Gaussian filter and provides detail preserving performance. In view of this, the bilateral total variation (BTV) model and non-local total variation (NLTV) model are successively exploited to more precisely restore the details by fusing the idea of bilateral filtering and non-local means filtering with TV criterion. However, the BTV model only considers the spatial distance but ignores the neighborhood similarity in obtaining the gradient of a pixel, which leads to the derogation of structure information in the recovered image. Moreover, the nonsymmetrical structure preserving ability of the NLTV model tends to be weakened with growing noise strength,

which may result from neglecting the robust local structure constraints.

In the process of image transmission, reception, etc., the noise greatly reduces the reliability and quality of the image. Therefore, image denoising is increasingly important in image processing. Image denoising can directly affect the subsequent work of image processing, and how to make the image remove noise without distortion as much as possible becomes the primary task of image denoising. In recent years, great progress has been made in image denoising, and the proposed image denoising algorithms can be roughly classified into the following categories: wavelet transform method, method based on total variation, and denoising method based on sparse representation, etc. [2].

Image denoising is a problem of fundamental importance for enhancement of quality in image restoration and computer vision. Due to the current trend of decreasing size of CMOS/CCD sensors, pixels capture less light and images can be more easily corrupted by noise, which makes denoising of even greater benefit than previously for many image processing applications. The problem of image restoration has been studied with recent success by consideration of image prior information, i.e., by learning consistent structure and texture information from the image being denoised or from other natural images. Numerous denoising models based on priors have been proposed. A common approach is to learn the priors from the given noisy image itself [6[.

Clamor displaying in pictures is incredibly influenced by catching instruments, information transmission media, picture quantization and discrete wellsprings of radiation. Diverse calculations are utilized relying upon the commotion demonstrate. A large portion of the characteristic pictures are accepted to have added substance arbitrary commotion which is displayed as a Gaussian. Dot clamor [1] is seen in ultrasound pictures while Rician commotion influences MRI pictures. Picture Denoising has remained a principal issue in the field of picture preparing. Wavelets give a better execution in picture denoising due than properties, for example, sparsity and multiresolution structure. With Wavelet Transform picking up fame in the most recent two decades' different calculations for denoising in wavelet space were presented.

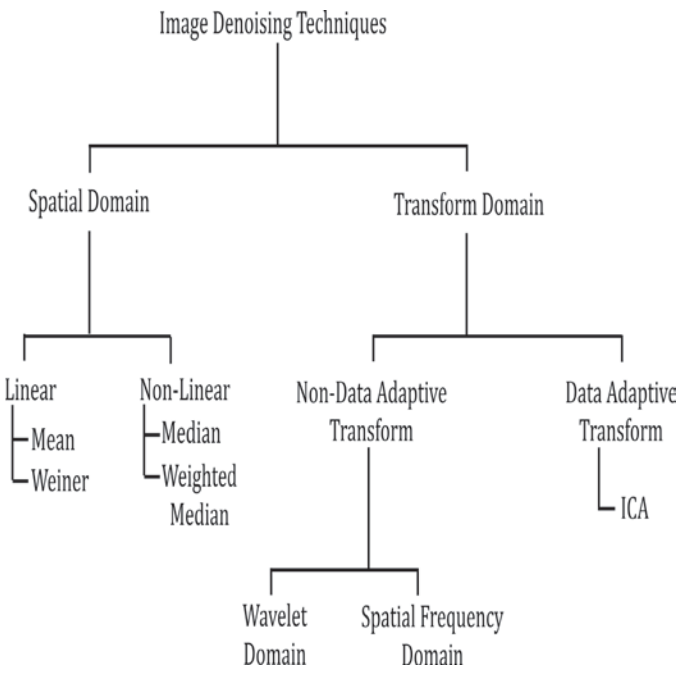

Fig 1: Shows that classification of denosing algorithm for image processing.

II WAVELET BASED DENOISING

Wavelet transforms are now being adopted for a vast number of applications, often replacing the conventional Fourier Transform. Many areas of research in various scientific fields have seen this paradigm shift towards the use of wavelets, including astrophysics, seismic geophysics, optics, medical imaging, remote sensing etc. Any data which is severely affected by noise has got the inherent limitation of interpretation and analysis. Automatic software analysis tools meant for interpreting such data invariably gives erroneous results if used on noisy data sets, and hence such data are not useful for subsequent applications. Of late wavelets, have been found to be useful for various signal and image processing tasks as has been reported. The time-frequency domain analysis scope renders such technique very useful in the domains of signal or image compression, denoising, image enhancement, resolution enhancement, fractals etc. However most of the results have been shown on simulated or optical data sets. In the field of actual SAR data denoising has mostly been done on medium resolution images such as those from ERS, Radarsat-1 etc. having around 25m resolution, which have a different scattering characteristic compared to that of higher resolution ones. One method was reported which showed that contourlet transform gave better edge preserving and speckle removal compared to normal wavelet based filtering for SAR data. However the operation was performed on logarithmically compressed data, which invariably reduces the dynamic range of the original signal and may not be desirable for very high resolution images.

III RELATED WORK

Image denoising is one of the most extensively studied topics in image processing. There are many types of image denoising methods, such as filtering i.e., BM3D), effective prior i.e., EPLL) and low-rank i.e., WNNM. Here we present the literature review for the image denoising techniques and their applications.

[1] In this paper, a new approach to solve the sparse coding step is proposed. Because this step involves an λ0 -norm, most, if not all, existing solutions only provide a local or approximate solution. Instead, a real λ 0 optimization is considered for the sparse coding problem providing a global solution. The proposed method reformulates the optimization problem as a mixed-integer quadratic program (MIQP), allowing then to obtain the global optimal solution by using an off-the-shelf optimization software. Because computing time is the main disadvantage of this approach, two techniques are proposed to improve its computational speed.

[2] The improved IWNNM algorithm proposed in this paper has pretty good denoising effect in some aspects, but it also has some shortcomings that we cannot handle successfully. For example, when the intensity of the mixed noise is relatively low, it is obvious to see that the denoising performance is excellent, but when the intensity of the mixed noise is relatively high, the effect could get a little worse. So how to ensure that the algorithm achieves excellent removal ability regardless of whether the mixed noise intensity is high or low is the focus of subsequent research.

[3] This paper is a brief introduction to image denoising technology. In this paper, image-denoising technology is summarized, including the concept of noise and denoising principle, and some basic image denoising methods are introduced. The optimized noise estimation method is proposed for the above phenomena and actual needs by PCA and variance stable transform. In addition, the innovative concept of introducing excessive noise peaks in this paper greatly improves the precision of noise estimation by judging the proportion of noise distribution. This paper estimates the VST transform parameters by the excessive peak minimization, the optimized noise estimation can better obtain the denoising effect and suppress the interference of hardware, which can be widely used in actual production in the future.

[4] In this paper they propose a DRDN model for noise reduction of real-world images. Their proposed DRDN makes full use of the properties of residual connection and deep supervision. They present a method to denoise images with different noise amounts and simultaneously reduce the average computational cost. The core idea of their method is to dynamically change the number of blocks involved in denoising to change the denoising strength via sequential decision. Moreover, their method can manually adjust the denoising strength of the model without fine-tuning the parameters.

[6] They present a noise removal framework based on external prior learning and an internal mean sparse coding method, making use of the innate sparsity and nonlocal self-similarity (NSS) of natural images. Specifically, we first obtain external priors from a clean natural image dataset by Gaussian mixture model. The external priors are applied to guide the subspace clustering of internal noisy image patches, and a compact dictionary is generated for each internal noisy patch cluster. Then an internal mean sparse coding strategy based on NSS is introduced into the sparse representation model, whose regularization parameters then are deduced through a Bayesian framework. An iterative shrinkage method is employed to solve the l1-optimization problem in the sparse representation model.

[7] In this paper author approach is good in performance on the quality improvement of the medical images, but it has low computational speed with high computational complexity. In view of the above limitations, this chapter proposes a novel strategy for denoising insight phenomena of the K-SVD algorithm. In addition, the authors utilize the technology of improved dictionary learning of the image patches using heap sort mechanism followed by dictionary updating process. The experimental results validate that the proposed approach successfully reduced noise levels on various test image datasets.

[8] To eliminate heavy noise and retain more scene details, they propose a structure-oriented total variation (TV) model based on data dependent kernel function and TV criterion for image denoising application. The innovative model introduces the weights produced from the local and nonlocal symmetry features involved in the image itself to pick more precise solutions in the TV denoising process. As a result, the proposed local and nonlocal steering kernel weighted TV model yields excellent noise suppression and structure-preserving performance. The experimental results verify the validity of the proposed model in objective quantitative indices and subjective visual appearance.

[10] According to researchers, Coherent systems such as Synthetic Aperture Radar(SAR), Ultra Sonography (USG), or MRI (Magnetic Resonance Imaging) are inherently affected by a grainy kind of noise called the speckle noise. The presence of such noise degrades the radiometry of the images and renders such image difficult for image analysis or interpretation. The applications involving classification, segmentation or texture analysis of the amplitude data from SAR invariably need a speckle reduced image for proper data analysis.

[11] Creator introduced, a Kinect depth de-noising algorithm is discussed to enhance the stability and reliability of Kinect depth map by exploiting spatial-temporal depth classification beside edges. Depth edges are realigned by extracted texture edges. Spatial and temporal depth classification is retrieved and exploited adaptively to remove the blurs around the edges. Experimental results demonstrate that the discussed algorithm provides much sharper and clearer edges for the Kinect depth. Compared with the original depth and the depths refined by existing approaches, the spatial-temporal de-noised depth information provided by the discussed approach enhances the quality of some advanced processing e.g. 3D reconstruction prospectively.

[12]In this paper, a new method for impulsive noise reduction and edge preservation in images is presented. Images of different characteristics corrupted with a wide range of impulsive noise densities using two impulsive noise models are examined using the discussed method. In the detection stage of the method, two conditions have to be met to determine whether an image pixel is noisy or not. Two predetermined threshold values are involved in the computation of the second condition to differentiate between corrupted and uncorrupted pixels. Only pixels determined to be noisy in the detection stage are filtered in the next filtering stage where small size sliding windows are used to significantly reduce blurring effects in

the output restored images. Several measuring indices have been used to examine the performance of the discussed method compared with many existing state-of-the-art methods in the literature of the image restoration field.

[13] authors discuss a new energy model simultaneously estimating motion flow and the latent image based on robust total variation (TV)-L1 model. This approach is necessary to handle abrupt changes in motion without segmentation. Furthermore, they address the problem of the traditional coarse-to-fine deblurring frame-work, which gives rise to artifacts when restoring small structures with distinct motion. They thus discuss a novel kernel re-initialization method which reduces the error of motion flow propagated from a coarser level. Moreover, a highly effective convex optimization-based solution mitigating the computational difficulties of the TV-L1 model is established. Comparative experimental results on challenging real blurry images demonstrate the efficiency of the discussed method.

[14] They discussed different types of the noise for Kinect are analyzed and a unique technique is used, to reduce the background noise based on distance between Kinect devise and the user. Whereas, for shadow removal, the iterative method is used to eliminate the shadow casted by the Kinect. A 3D depth image is obtained as a result with good quality and accuracy. Further, the results of this present study reveal that the image background is eliminated completely and the 3D image quality in depth map has been enhanced. In this paper, the Kinect device, its features, noising types were discussed. A unique technique of eliminating noise and background from an image; obtained through the Kinect device, is discussed.

[15] Researchers defined extend this line of study to the denoising of synthetic aperture radar (SAR) images based on clustering the noisy image into disjoint local regions with similar spatial structure and denoising each region by the linear minimum mean-square error (LMMSE) filtering in principal component analysis (PCA) domain. Both clustering and denoising are per-formed on image patches. For clustering, to reduce dimensionality and resist the influence of noise, several leading principal components identified by the minimum description length criterion are used to feed the K-means clustering algorithm. For denoising, to avoid the limitations of the homo-morphic approach, they build their denoising scheme on additive signal-dependent noise model and derive a PCA-based LMMSE denoising model for multiplicative noise.

[16] According to authors, wavelet methods have been widely used for analyzing remote sensing images and signals. The second-generation of wavelets, which is designed based on a method called the lifting scheme, is almost a new version of wavelets, and its application in the remote sensing field is fresh. Although first-generation wavelets have been proven to offer effective techniques for processing remotely sensed data, second-generation wavelets are more efficient in some respects, as will be discussed later. The aim of this review paper is to examine all existing studies in the literature related to applying second-generation wavelets for denoising remote sensing data.

IV CONCLUSION AND FUTURE SCOPE

With the development of science and technology and the need of work and life, the application of digital image filtering will be more and more extensive, and the requirements will be higher and higher. So far, there are still many new ideas and methods in denoising, and constantly enrich image denoising methods. This paper is a brief introduction to image denoising technology. In this paper, image-denoising technology is summarized, including the concept of noise and denoising principle, and some basic image denoising methods are introduced. In this paper we review the various techniques related to image denoising techniques and in future need to enhance the image quality.

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