ISSN: 2581-3404 (Online) **IF: 5.445 (SJIF)**

International Journal of Innovative Research in Technology and Management, Volume-6, Issue-2, 2022.

A Review on Image Denoising by Different Techniques

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Abstract: *In the modern era of digitization, digital images and documents contribute to a large subset of the generated digital data. The easy availability of cameras, imaging devices, and the ever-decreasing cost of memory has enabled humans to capture images readily. As imaging technology advances, the expectations of the quality of images are also increasing. Although the imaging sensor always tries to capture the fine and exact details in an image, it is inherently accompanied by specific amounts of noise. In this paper we discuss the different techniques to remove the noise form an image and enhance quality of recovered image.*

Keywords: Edge detection, Noise, Image denoising, Clustering, classification.

Introduction

Digital communication play an important role in building a civilized society and reducing a communication gap between relatives and friends. The current civilized society demand fast and reliable communication in concern of wired and wireless communication system. The reliability of communication depends on the quality of received signal. In transmission of digital signal passes through open environment fading of signal are occurred. The fading of signal attenuated the signal strength and quality of signal compromised. High-speed data transmission through channels with severe distortion can be achieved by designing an equalizer in the receiver that counteracts the channel distortion. Communication channels introduce linear and nonlinear distortion, secret cases of significance; they cannot be considered memory less.

Image denoising is one of the basic tasks for the researchers dealing with image processing since there may occur distortions of images during the acquisition, processing, compression, transmission or reconstruction processes. Therefore, it is important to eliminate the noise from the images and increase the quality, or produce good estimates from noisy ones. Images are affected by noise during their acquisition and transmission. Therefore, the denoising process is necessary to achieve higher quality images. However, both edges of the image and noise are characterized by high frequencies, loss of edge information may become unavoidable as a result of the denoising process. Thus, recovered, denoised images, become blurrier or less denoised. Therefore, a wavelet threshold denoising technique, based on edge detection, can be used to preserve more edge information and enhance the quality of the denoised image. The image noise can be Gauss, Poisson, or particle noise. The visuality and processing of the image are both affected by the noise. Therefore, it is aimed to preserve the useful information of the image and to reduce the noise by the image denoising process. Since denoising is a preliminary process in the field of image processing, almost all researchers interested in image processing have dealt with this problem and therefore researches on this effect made significant progress. Spectrum distribution is used for the traditional image denoising algorithms. Image denoising is one of the most important applications in image processing. Using the knowledge that high frequencies characterize noise as well as edges, the denoising process and edge detection can be combined. Thus, deficiencies in commonly used denoising methods can be overcome. Although many denoising and edge detection methods are used today, different methods can be useful in different noise and image types. In the wavelet edge detection method, it is important to determine the appropriate threshold value while thresholding wavelet coefficients because noises are not clustered in a few wavelet coefficients.

Noise is the unwanted energy which is mixed during the acquisition, transmission, and/or reconstruction of an image. Though the noise cannot be altogether eliminated, however, it can be reduced at acquisition time. Post-processing of acquired imagery using data processing algorithms is used to reduce its effects. In such applications, denoising is a major challenge for the researchers [8]. Denoising is an inverse ill-posed problem which is classically addressed by specifying a forward model and then inverts it for the unknowns. Recent developments are exploring the use of deep learning techniques for the denoising. Denoising is the fundamental step in medical image processing applications while doctors and medical practitioners most often rely on these processed images for the diagnosis. In particular, magnetic resonance imaging (MRI) and computed tomography (CT) scans are used to observe the internal structure as well as any defects like tumors or injuries present inside the body. Generally, MRI and CT images are affected by noise due to fluctuations in temperature of the scanner room, disturbance in the scanning machines and/or patient's movement during the image acquisition. Due to the noise, magnitude of the pixel/voxel values in the images/image stack are perturbed which leads to artifacts and loss of details in the images. It makes the diagnosis and disease prediction complicated. The main considerations involved in medical image denoising algorithms include: a) edges in the denoised image should be preserved, i.e., filtering performed for denoising should not blur out the finer details of imagery and while at the same time, b) the visual quality of the denoised image should be preserved and improved.

II. Literature Review

[1] Noise type and strength estimation are important in many image processing applications like denoising, compression, video tracking, etc. There are many existing methods for estimation of the type of noise and its strength in digital images. These methods mostly rely on the transform or spatial domain information of images. They propose a hybrid Discrete Wavelet Transform (DWT) and edge information removal based algorithm to estimate the strength of Gaussian noise in digital images. The wavelet coefficients corresponding to spatial domain edges are excluded from noise estimate calculation using a Sobel edge detector. The accuracy of the proposed algorithm is further increased using polynomial regression. Parseval's theorem mathematically validates the proposed algorithm. Hyperspectral images (HSI) are corrupted by a combination of Gaussian and impulse noise. Successful denoising of HSI data increases the accuracy of high-level vision operations like classification, target tracking and land-cover problem. On the one hand, the traditional approach of handling the denoising problem using maximum a posteriori (MAP) criterion is often restricted by the time-consuming iterative optimization process and design of hand-crafted priors to obtain an optimal result. On the other hand, the discriminative learning-based approaches offer fast inference speed over a trained model; but are highly sensitive to the noise level used for training. A discriminative model trained with a loss function which does not accord with the Bayesian degradation process often leads to sub-optimal results. In this paper [2], they design the training paradigm emphasizing the role of loss functions in neural network; similar to as observed in model-based optimization methods. Further,

Bayesian motivated loss functions also act as priors to constrain the solution space to the types of noise observed in hyperspectral image acquisition process. As a result, loss functions derived in Bayesian setting and employed in neural network training boosts the denoising performance. Extensive analysis and experimental results on synthetically corrupted and real hyperspectral datasets suggest the potential applicability of the proposed technique under a wide range of homogeneous and heterogeneous noisy settings. Haze reduces the contrast of an image and causes the loss in colors, which has a negative effect on the subsequent object detection; therefore, single image dehazing is a challenging visual task. In addition, defects exist in previous existing dehazing approaches: Pixel-based dehazing approaches are likely to result in insufficient information to estimate the transmission, whereas patch-based ones are prone to generate shadows. They both also tend to induce color deviations. Therefore, this study [5] proposes a novel method based on multi-scale wavelet and non-local dehazing. A hazy image is first decomposed into a low-frequency and three high-frequency sub-images by wavelet transform. Non-local dehazing and wavelet denoising are then employed on the low-frequency and high-frequency sub-images to remove the haze and noise, respectively. Finally, a haze-free image is obtained from the reconstruction of sub-images. Deep convolutional neural networks (CNNs) for image denoising have recently attracted increasing research interest. However, plain networks cannot recover fine details for a complex task, such as real noisy images. In this paper, [6] they propose a Dual denoising Network (DudeNet) to recover a clean image. Specifically, DudeNet consists of four modules: a feature extraction block, an enhancement block, a compression block, and a reconstruction block. The feature extraction block with a sparse mechanism extracts global and local features via two sub-networks. The enhancement block gathers and fuses the global and local features to provide complementary information for the latter network. The compression block refines the extracted information and compresses the network. Finally, the reconstruction block is utilized to reconstruct a denoised image. The DudeNet has the following advantages: (1) The dual networks with a parse mechanism can extract complementary features to enhance the generalized ability of denoiser. (2) Fusing global and local features can extract salient features to recover fine details for complex noisy images. (3) A Small-size filter is used to reduce the complexity of denoiser. [7] They introduce an image denoising algorithm which utilizes a novel online dictionary learning procedure together with patch ordering. The developed algorithm employs both the non-local image processing power of patch ordering and the sequential patch-based update of online dictionary learning. The patch ordering process exploits the similarities between patches of a given image which are extracted from different locations. Joint processing of the ordered set of image patches facilitates the non-local image processing ability of the algorithm. The algorithm starts with the extraction of a maximally overlapped set of patches from the given noisy image. Then, the extracted patches are reordered by using a distance measure, and the 3D ordered patch cube is formed. The ordered patch cube is used sequentially to update an over complete dictionary. In each iteration, firstly the present patch is denoised using sparse coding over the current over complete dictionary. Secondly, the over complete dictionary is updated using the current image patch, and the dictionary is passed to the next iteration. X-ray acquisitions are beneficial in food contaminant analysis as they can detect both metallic and non-metallic objects. This paper considers the scenario of single-pixel hyperspectral X-ray acquisitions applied to a series of materials with different characteristics. They propose [11] a method that jointly applies a denoising operation and detects the analysed material in terms of a physical parameterisation. The proposed algorithm is based on a Convolutional Neural Network (CNN) trained with a multitask learning strategy using a custom loss function tailored to the problem at hand. Experimental results on metals and polymers show that the proposed method can also generalise to materials never seen at training time.

III. Wavelet Based Denoising

Wavelet changes are currently being received for countless, frequently supplanting the ordinary Fourier Transform. Numerous ranges of research in different logical fields have seen this outlook change towards the utilization of wavelets, including astronomy, seismic geophysics, optics, therapeutic imaging, remote detecting and so on. Any information which is extremely influenced by commotion has the inborn confinement of elucidation and examination. Programmed programming investigation apparatuses implied for deciphering such information constantly gives wrong outcomes if utilized on loud informational collections, and henceforth such information are not valuable for ensuing applications. Recently wavelets, have been observed to be helpful for different flag and picture preparing undertakings as has been accounted for. The time-recurrence area investigation scope renders such system extremely valuable in the spaces of flag or picture pressure, denoising, picture improvement, determination upgrade, fractals and so on. However the vast majority of the outcomes have been appeared on recreated or optical informational indexes. In the field of genuine SAR information denoising has for the most part been done on medium determination pictures, for example, those from ERS, Radarsat-1 and so forth having around 25m determination, which have an alternate dissipating trademark contrasted with that of higher determination ones. One technique was accounted for which demonstrated that contourlet change gave better edge safeguarding and spot expulsion contrasted with ordinary wavelet based sifting for SAR information. In any case, the operation was performed on logarithmically packed information, which constantly diminishes the dynamic scope of the first flag and may not be alluring for high determination pictures. A large portion of the sifting connected on SAR pictures to enhance the dot do as such at the cost of spatial determination. With the appearance of high determination SAR information from different satellites, for example, Terrasar-X or Cosmo-Skymed, it turns into a testing undertaking to consider denoising of such information however with the negligible obscuring. Wavelet based denoising are being picked keeping in mind the end goal to go around this issue [1].

IV. Conclusion

In recent developments of modern digital image analysis, denoising assumes a key part of image processing. Denoising is an elementary issue of signal improvement in image processing then it requires moderating the noise levels of the detected images while stabilizing the texture features, corner features and edge particulars of the original image. Image denoising is the method of reducing the noise levels, which makes imaging analysis easier. The aim of denoising method is to reduce the noise levels homogeneous regions while stabilizing the image forms and reconstruct the original image form. In this paper we present the review work on different image denoising techniques and their impact with applications.

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