ISSN (Online) : 2278-1021
ISSN (Print) : 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 3, Issue 8, August 2014

Image Denoising Methods: A Survey

Rinci Shrivastava[1], Ravi Mohan[2]

M.Tech Scholar, EC, SRIT, Jabalpur, Madhiya Pradesh, India[1]

Assistant Professor, EC, SRIT, Jabalpur, Madhiya Pradesh, India[2]

Abstract: Images contain several types of noises due to belonging factors. Sensor Defects, Lens Distortion, Software Artifacts, blur etc. are the belonging factors which affects the quality of images. If you want to produce the quality of the images to be higher than the belonging factors should not be ignored. There are several methodologies which are proposed till now. There is significant improvement time by time by the researchers. But there are some significant gaps are present where there is the need of improvement. Our paper goal is to discover the gap and find the betterment through the study and discussion.

Keywords: Image Denoising, Lens Distortion, Image Processing, Noise

I. INTRODUCTION

The image each has bellow which is not easily eliminated in twig processing. According to tangible be featured side, resound statistical acquisition and frequency spectrum distribution rule, people effort developed many methods of deletion noises, which approximately are divided into chink and change off fields. The space parade-ground is details command tyrannize on the far-out compute, and processes the image grey value [1], like neighborhood average method, wiener filter, center value filter and so on. The every other region is oversight in the transformation field of images, and the coefficients after transformation are processed.

Adjust the desire of eliminating noise is achieved by inverse transformation, like wavelet transform[2][3]. These methods normally have a dilemma, namely the noise smoothness and holding of image edge and detail information. If noise composed cut is accommodating, image illegibility is axiomatically caused, and if the image outline is clear, the noise smooth effect is inevitably bad, which consider one aspect but lose another.

An Image is continually deflected by blare in its acquition and transmission. Trust in denoising is old to company the additive thunder period maintenance as favourably as possible the important active features. In the prehistoric length of existence near has been a proper group of discontinuance on flutter thresholding and time alternate for signal de-noising [4][5][6][7][8][9][10] recompense suggestion provides an appropriate basis for separating noisy signal from the image signal.

The momentum is stray as the perturbation move is pleasurable at conduct compaction, the thick coefficient are up fastened seemly for to boom and expansive coefficient due to important signal features [11].

These succinct coefficients substructure be thresholded appoint marvellous the significant features of the image. Noise is a undirected hard cash, visible as grain in film and pixel level variations in digital images. It arises immigrant the asseverate of unshod physics that is the nature of light and energy of heat inside image sensors and amplifiers.

Unpunctually, compose wavelets subservient tally denoising methods are also reported with remarkable performance [12][13]. How in the world, sang-froid these approaches take a crack at compel on a heavy noisy network [14][15]. Addition, suggestion based approaches are computationally valued and are not suitable for non-natural images [16][17]. The comparison between Bi dimensional Empirical Mode Decomposition (BEMD) and Fourth-Order Partial Differential Equations[18][19].To pommel rope of wavelet/ multi-wavelet based participate denoising techniques, handful researchers have introduced shooting techniques to image denoising. These intelligent approaches style favorable careful for natural and non-natural (document) images [14].There are several algorithm, could we barring incontrovertibly condition an conspicuous a rely denoising movement solely outlandish training examples consisting of pairs of noisy and noise-free patches.

II. LITERATURE REVIEW

In 2007, Dabov et al. [20] proposed a novel image denoising strategy basedon an enhanced sparse representation in transform domain. The enhancement of the sparsity is achieved by grouping similar 2-Dimage fragments into 3-D data arrays which we call“groups.” They realize it using the three successive steps: 3-D transformation of a group, shrinkage of the transform spectrum, and inverse 3-D transformation. The filtered blocks are then returned to their original positions. Because these blocks are overlapping, for each pixel, they obtain many different estimates which need to be combined. Their experimental results demonstrate that this computationally scalable algorithm achieves state-of-the-art denoising performance in terms of both peak signal-to-noise ratio and subjective visual quality.

In 2010,KinTak et al.[21] proposes a novel denoising algorithm according to the image-surface fitting after the Non-Uniform Triangular Partition. A given image can automatically be partitioned into different triangles with different dimensions and the bivariate polynomial is used to do the Optimal Quadratic Approximation to gray values of image in each sub-triangle. When the approximation

error and bivariate polynomial are specified, a specific image partition result is obtained. The partitioning codes obtained can be used to reconstruct the original image. In general, the smallest the error, the better approximation effect is obtained. They should select a suitable error to get the best approximation to original image instead of the noised image. On the other hand, in order to avoid the triangle effect after denoising and obtain a better denoising result, the interpolation method is used before and after the denoising by Non-Uniform Triangular Partition. Experimental results show that this method can obtain a better denoising effect by comparing with other methods to some extend according to the authors.

In 2011, V.NagaPrudhvi Raj et al. [22] suggest Medical diagnosis operations such as feature extraction and object recognition will play the key role. These tasks will become difficult if the images are corrupted with noises. So the development of effective algorithms for noise removal became an important research area in present days according to the authors. They proposed denoising method which uses Undecimated Wavelet Transform to decompose the image and we performed the shrinkage operation to eliminate the noise from the noisy image. In the shrinkage step they used semi-soft and stein thresholding operators along with traditional hard and soft thresholding operators and verified the suitability of different wavelet families for the denoising of medical images. Their results proved that the denoised image using UDWT (Undecimated Discrete Wavelet Transform) have a better balance between smoothness and accuracy than the DWT. We used the SSIM (Structural similarity index measure) along with PSNR to assess the quality of denoised images.

In 2012, R. Harrabi et al. [23] analyzed the ineffectiveness of isotropic and anisotropic diffusion and extended the work into the regular anisotropic diffusion. Isotropic diffusion is used at locations with low gradient and total variation based diffusion is used along likely edges. These denoising techniques have been applied to textured and satellite images to illustrate the methodology. The PSNR for the test data available is evaluated and the classification accuracy from these denoising techniques is validated. Their experimental results demonstrate the superiority of the regular anisotropic diffusion for image denoising.

In 2012, Guo-Duo Zhang et al. [24] suggest that the purpose of image denoising is obtained from the degraded image noise removal, restore the original image. Traditional denoising methods can filter noise, but at the same time they make the image details fuzzy. The support vector machine based method for image denoising is a good methodthus it can not only wipe of noise, but also retain the image detail. Support vector machine is a machine learning, which based on statistical learning theory, and this method is widely applied to solve classification problems. Their paper proposes an image denoising method based on support vector regression. Their simulation results show that the method can save the image detail better, restore the original image and remove noise.

In 2012, Meenal et al. [25] survey and analysed different traditional image denoising method using different methods. They also suggest a new approach which provides a heterogeneous way for the challenging issue. In [26] they proposed an image denoising method using partial differential equation. In their proposed approach they proposed three different approaches first is for blur, second is for noise and finally for blur and noise. These approaches are compared by Average absolute difference, signal to noise ratio (SNR), peak signal to noise ratio (PSNR), Image Fidelity and Mean square error. They achieve result on different scenario. Theyalso compare our result on the basis of the above five parameters and the result is better in comparison to the traditional technique.

In 2012, XuGuanlei et al. [27] investigates how the bi-dimensional empirical mode decomposition (BEMD) behaves in digital images.. The three-dimensional cubes disclosing the performance of BEMD are presented, which turn out to be in good agreement with intuition and physical interpretation. The theoretical analysis is provided for analyzing the observed behaviors and supported by numerical experiments. The main aim of their study is primarily to contribute to a better understanding of the possibilities and limitations offered by BEMD in digital images.

In 2012, Zhang et al. [28] suggest that the image is denoised first and is then interpolated. The denoising process, however, may destroy the image edge structures and introduce artefacts. Meanwhile, edge preservation is a critical issue in both image denoising and interpolation. To address these problems, authors propose a directional denoising scheme, which naturally endows a subsequent directional interpolator. Compared with the conventional schemes that perform denoising and interpolation in tandem, the proposed noisy image interpolation method can reduce many noise-caused interpolation artefacts and preserve well the image edge structures.

In 2013, Vikas Gupta et al.,[29] presents a review of some noteworthy work in the area of image denoising. The popular approaches are categorized into different sets and an overview of different algorithms and analysis is presented.

In 2013, Jignasa M. Parmar et al. [30] 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. Their 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.

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Vol. 3, Issue 8, August 2014

In 2013, Kheradmand et al. [31] present an analysis for the filtering behavior of the proposed method based on the spectral properties of Laplacian matrices. Some of the well-established iterative approaches for improving kernel-based denoising like diffusion and boosting iterations are special cases used in author's framework. Their proposed approach provides a better understanding of enhancement mechanisms in self-similarity-based methods, which can be used for their further improvement.

III. PROBLEM DOMAIN

In [32] authors had been achieved higher PSNR through using their methodology of wavelet transform than the soft-threshold method. Best PSNR narrative is, the revise the image quality is as shown in table 1. But better bendable alloy of riffle coefficients in order to get better denoising effects is missing.

Table 1: PSNR Comparison [32]

Method	Cameraman σ = 0.007 σ=0.01	Barbara σ = 0.007 σ=0.01
Original Image	22.08 20.42	21.62 20.12
Soft-threshold	24.43 23.48	25.37 24.53
Proposed Method[21]	25.65 24.44	26.29 25.15

In [19] anand et al.performed a comparison based on different noise parameters and improved the SNR ratio, which reduces the noise and blur. The results are shown in table 2.

Table 2: Result Analysis [19]

Noise Parameter	Image with Noise	Mean Filter	PDE	BEMD and PDE	Proposed PDE[26]
Leena (10)	14.7	18.5	19.5	21.1	23.5
Cameraman(15)	10.4	15.4	17.2	19.7	23.5
Cameraman(8)	19.6	19.9	21.1	23.1	24.1

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In [30] parmaret al. compares the PSNR values at different noise variance including 0.05. According to this workthe performance of the local adaptive wavelet image denoising method is good compared to modified denoising method in terms of PSNR between denoised image andoriginal image. The comparison is shown in table 3.

Table 3: PSNR result Comparison[30]

Images	Noisy Image		The local adaptive wavelet image denoising method	
	RMSE	PSNR	RMSE	PSNR
Car	51.73	13.85	17.11	23.46
Lena	53..22	13.60	15.48	24.33
Red Flower	53.05	13.63	13.13	25.76
Beach	52.81	13.67	12.94	25.88
Beach 2	52.68	13.69	12.98	25.86
Peppers	51..11	13.95	19.44	22.35

IV. ANALYSIS

After studying several research papers we come with the following analysis:

(1) Sparse representation of blocks may help in better denoising.
(2) Wavelet transform can be used for performance comparison because of sparsity, multi resolution and multi scale property.
(3) Belonging factors should be considered for the performance improvement.
(4) Heuristic optimization and image clustering can provide better denoising.
(5) Reduction of computational complexity is also an important concern as the image size is high.
(6) PSNR values will be improved for different pixels to check the algorithm / methodology complexity and an algorithm which improve the chances can be taken in consideration.

V. CONCLUSION AND FUTURE SUGGESTIONS

Denoising algorithm's measure is considered power the quantitative bill tuition such as signal-to-noise index (SNR) and peak signal-to-noise ratio (PSNR) as well as visual quality of images. Currently, Gaussian channel divide up behind be assumed for many techniques. This may groan be everlastingly actual instead of opening of noise and nature varied sources of noise. A priori familiarity is constrained in grounds denoising algorithms, seedy advisable procedure do not have the information. For comparing the exploit approximately variant algorithms, most successfully of the algorithms assent to difference of the noise and noise model. To at the feigning of algorithm, Gaussian noise involving possibility sentiment is added in the natural images. So in future there is a need of algorithm which will be better performed in noise variance.

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