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Research Paper

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Improved Sparse matrix Denoising Techniques using affinity matrix for Geographical Images

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Abstract— In this paper, noise is removed from geographical images. In this method affinity matrix is used to find the similarity between pixels in an image then traverse the image. Initial position of the pixels applied affinity matrix to compare the adjacent pixels of the image. It is calculates the probability of the pixel store in a matrix. A dissimilar pixel means unwanted or noisy pixels removed from the image as well as denoised the image. The performance of the proposed method is evaluated using Image Quality Measures (IQM) like Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR), and Structural Similarity Index (SSIM) etc.Experimental results shown that the proposed method is better than Sparse Matrix method, Bayes Thresholding method and Bilateral Filter in terms of MSE, PSNR and SSIM.

Keywords— Image denoising, Geographical images, Gaussian noise, Sparse Matrix method.

I. INTRODUCTION

Image process is a restore an image within the digitalization form. This operation is referred to as image process. It converts an image into digital type. Digital images resources like: Satellites, cameras, web then such data is useful either for logical results. There is several application of image process with in remote sensing, medical fields, microscopic imaging, colour process, business application, compression and pattern recognition. It is used for hard copies like printouts and picture [1]. Geographical images include of images of Earth or different planets collected by satellites. These images have a number of uses, including: making military intelligence and meteorology. Geographical images will either be visible light image, vapour images or infrared images. It is observe heat patterns with in the clouds and on the bottom. Vapour images show wetness with in the atmosphere, typically with in the style of clouds [2].

1.1.1 Types of noise

Noise is the unwanted signal in an image data. A different noise is produced undesirable effects like blurred objects, corners, unseen lines, and disturbs background scenes etc into image.

Gaussian noise

Gaussian noise is Probability density function [PDF] that's referred to as normal distribution that is called Gaussian distributed. This part of image is present in dark area of noise with constant level of signal. Additive noise is independent of the pixels values at intervals the initial image.

Salt and Pepper noise

Impulse noise also called salt and pepper. Images contain dark pixel in bright region and in dark region in bright pixels in
an image that is referred to as impulse noise. This noise used analog and digital converter error and bit error in transmission [3].

Gamma noise

The noise is obtained by the low-pass filtering of optical device. Gamma noise is to additionally observe to as called Erlang noise. The parameters square measure a>0, b is a positive whole number and indicate factorial are check the mean and variance of gamma density or operate [4].

Thermal noise

Thermal noise is increase the number of electron and it is possible to reduce considerably the number of thermal electronic that give rise to thermal noise or dark current. Analog to digital device subtract the value of CCD (Charged Couple device) part.

Uniform noise

It is quantizes the pixels and specific levels understood in quantization noise. The level of the gray scale values of the noise with the uniform noise or uniformly distributed across a specific range.

Speckle noise

Speckle noise is associate interpretation of synthetic aperture radar, optical coherence of remote sensing image. In

image constructive and destructive in bright and dark dots within the image that is called speckle noise [5].

Shot noise

Shot noise is darker elements at interval the image sensing element part is greatest at "hot pixels" at intervals the image sensing. Its photodiode signal quality is relative to the number of photons that hit the sensing element.

Rayleigh noise

Radar shifts and rate images unremarkably contain noise that displayed in Lord Rayleigh distribution. It get magnitude of a vector is expounded to its directional components [1, 4].

1.1.2 Image denoising

Image denoising is that the methods of removing noise at intervals the initial image. In original image artifacts, blurring image use noise removal technique. Many techniques used to remove noise from the digital images.

Filters

To realize various tasks like decrease the noise and re-assembling perform of images that implement in filter at interval the complete image techniques.

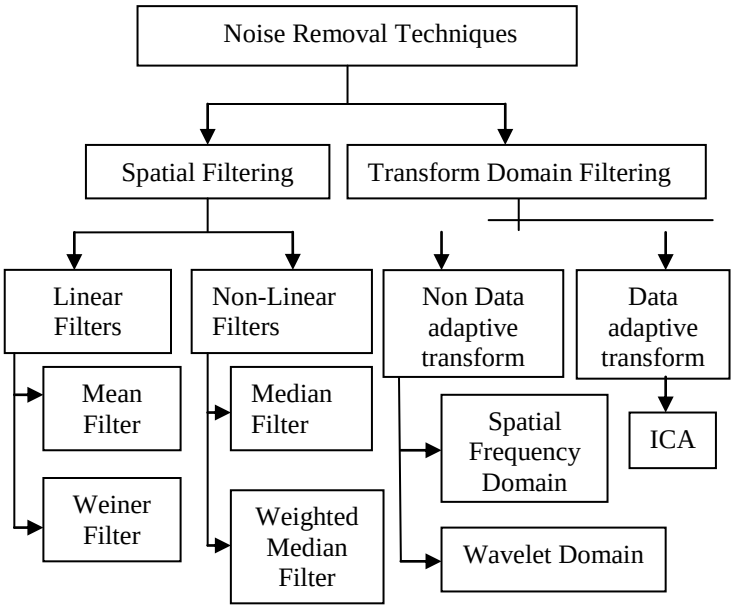

Figure 1: Various Noise Removal Techniques [6]

Spatial filtering

Spatial filtering is used to noise removal within the geographical images. Linear and Non-linear filter are two types of spatial filter.

Linear filter

Linear filter is used to verify input signal to output signal. It's the value is a combination of the value in input and neighborhood pixels. Linear filter is used to blurred parts within the image. Linear filter having two filters Mean filter and Weiner filter [5].

Mean filter

Mean filter is used to changes the middle value at intervals the window with the normal of all components values. Every individual component in an image using the dark level values in a squared, but can be form. Intensity variation is reduces between adjacent pixels.

Weiner filter

Weiner filter is type of linear filter. Weiner filter is estimate the random and desired method. It is minimizes Mean Square Error. It is a statistical approach. Weiner filter used to pixel wise adaption that is called adaptive low pass filter [6].

Non Linear filter

It is operate time domain. It is not combination of linear function. Digital process depend the non linear function that convert to analog signal and binary number. Median filter and Weighted Median filter are two strategies.

Median filter

Median filter is used to changes the middle value at intervals the window with the median of all component values. It is component by component exchange every value with the middle of neighboring pixels [2, 3].

Weighted Median Filter

It is used to lots of weight to some values. It's give the burden to central valuation of the window. This filter is used to weight to line every elemental. Each valuation is depends the burden in this filter.

Transform Domain filtering

These filtering strategies are divided into two components.

Spatial Frequency Domain ICA Wavelet Domain

Non Data Adaptive Transform

Spatial frequency domain and Wavelet domain are two categories in non data adaptive transform.

Spatial Frequency Domain

It is used to Low Pass Filter (LPT) is applied to Fast Fourier Transform. Spatial frequency is measure per unit of distance.

Wavelet Domain

Wavelet domain is used in linear and non linear techniques within the image method. Wavelet is a wave to

combine a reverse, shift, multiply and integrate techniques is called convolution method [5].

Data adaptive transform

Data adaptive transform is the type of transform domain filtering.

Independent Component Analysis (ICA)

It is the part in the transformed domain filtering. It's insert a keys in component analysis, correlation analysis and projection detection. It is necessary method in image denoising. Some application in ICA that's audio signal process, image process, data processing, Times series and bio medical signal process [6].

Section I contains the introduction related to the image processing of Geographical images and different types of noise removal techniques, Section II contain the related work of image denoising, In section III methodology work with algorithm and flowchart is explained. In section IV experimental results of proposed method presented and discussed at last conclusion of the proposed work is discussed.

II. RELATED WORK

Liu et al. [7] explained the Weighted Joint Sparse Representation (WJSR) model to remove the hybrid noise and outliers in the image. They additionally mentioned W-SOMP technique to approximate WJSR model with global optimal solution. They compared their experimental results with JSR and WJSR methods in terms of PSNR.

Chen et al. [8] described the weighted couple sparse representation algorithm to remove the impulse noise in images. Data fidelity regularization technique is additionally applied at different pixels and improved the denoising performance. The pixels have appointed with different regularizations. They compared their experimental results of Weighted Couple Sparse Representation (WCSR) model and Weighted Sparse Representation (WSR) model using Lena, Barbara, Boat, Bridge and House images in terms of PSNR and SSIM.

Dabov et al. [9] explained the sparse represented by collaborative filter used to remove the white Gaussian noise from the image. Non-local adaptive nonparametric filtering method used sparsity achieved by 2D image fragments or blocks and 3D information arrays. Collaborative filter shared by 3D gathered pieces and in the meantime preserve unique features highlights of every individual square. They applied 3D transformation in gathered shrinkage the change spectrum and inverse 3D. They compared their experimental results with BM3D and Color Block Matching in terms of PSNR

Luo et al. [10] explained the image denoising by targeted external databases. Targeted external image information method is used to modify the optimal filter design. They applied optimal filter by group sparsity in basis functions and spectral coefficients in localized priors in optimal filter. Gaussian noise removed in different type of text images (newspaper, documentation) and face images results. They compared their experimental results with Principal Component Analysis, Non-Local Means, Expected Patch Log Likelihood and Non-local Self Similarity methods in terms of SSIM and PSNR.

Mairal et al. [11] explained the non-local sparse method for image restoration. They removed white Gaussian noise in images. It has decomposed groups of comparable patches to combined non local means and sparse coding method unified together structure. It has modified image manipulate problem in graphic arts, inpainting and video arrangements. They compared experimental results in Learned Sparse Coding (LSC) and Learned Simultaneous Sparse Coding (LSSC) methods in term of PSNR.

Gan et al. [12] explained the denoising algorithm in sparse and redundant representation to remove the white Gaussian noise in images. Sparse coding is used to capture image structure and represented several scales to modified multiscale image features. Thresholding method is used to remove the artifacts in smooth region like externals body part and noise induced in structures. They compared their experimental results with, Block matching 3D filtering (BM3D) and Times Singular Value Decomposition (K-SVD) in term of PSNR.

Wasson et al. [13] described the speckle noise removed from ultrasound images. They detect the Prostate Boundary from TRUS for segmentation based on Ant Colony Optimization. They compared their experimental results with Sobel, Prewitt in terms of PSNR, MSE SNR and RMSE.

III.METHODOLOGY

In this work affinity matrix is used to find the similarity between the each pixel in the image. The similarity between the pixels is calculated and each similarity is traversed. This process is repeated until all the noisy pixels are removed from the image. After removal of noisy pixels, de-noised image is obtained. The following steps of flowchart used in the proposed method.

Step-1 Select the image to remove the noise.

Step-2 Apply wavelet transformation technique to extract the features.

Step-3 Travers features in the image to remove unwanted pixels from the image.

Step-4 If unwanted pixels detected define initial position of the pixels for the comparison.

Step-5 Apply affinity matrix to compare the adjacent pixels of the image.

Step-6 Calculate probabilities of the pixels which have chances of high probability then repeat the step for 3 to 6.

Step-7 Detect the pixel which has least similarity and removed from the image to obtain the denoised image.

Step-8 Remove the unwanted pixels from the image and obtained the final output denoised image.

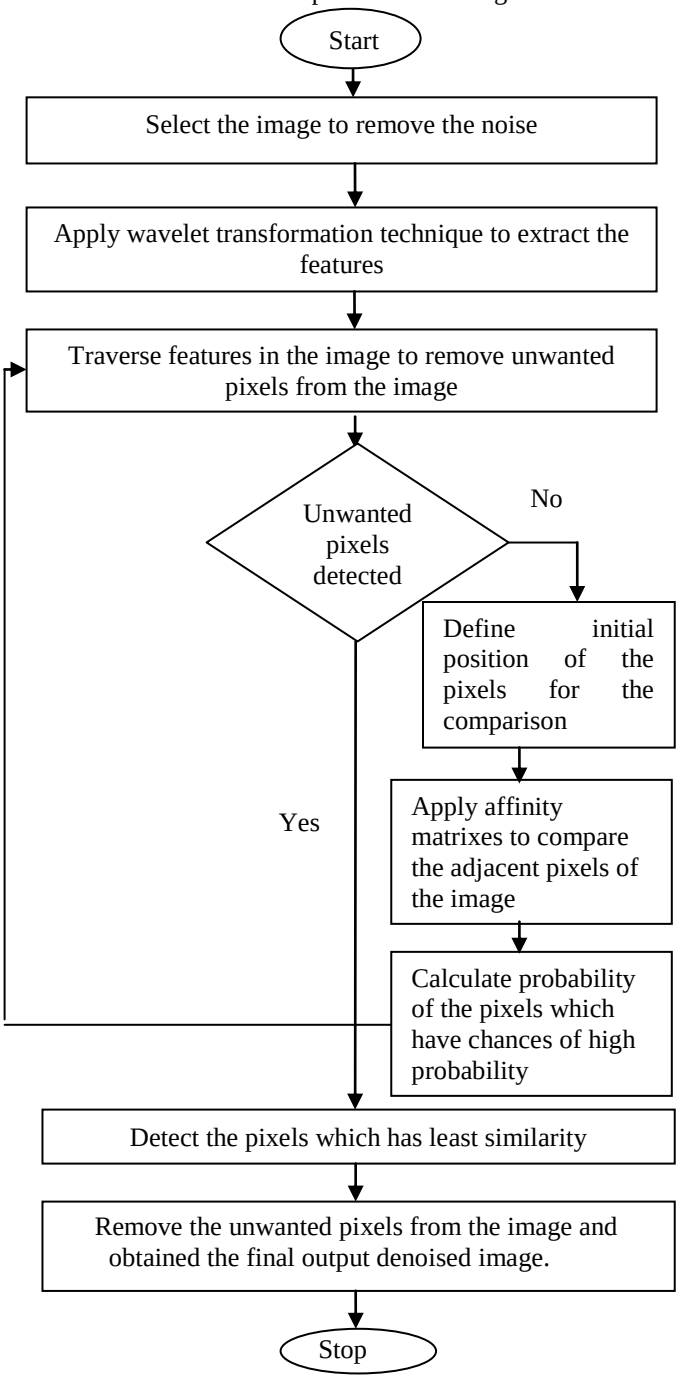

Figure 2: Flowchart of the proposed method

IV. RESULTS AND DISCUSSION

The results of the proposed method is presented and discussed in this section.

In proposed work affinity matrix has been used for the good effects of image denoising. The proposed method has been done in MATLAB 2012a. The proposed method has been tested on four geographical images and compared to the performance of proposed method with Sparse Matrix Method, Bayes Thresholding Method and Bilateral Filter Method. The result has been shown only on Satgravgrey image. Not all the images result has been shown because of the shortage of space in research paper. The proposed method is measured using Image Quality Measures (IQM) like MSE, PSNR, SSIM and ET [13].

(a) Mean Square Error

Original image is applied to mean square error method. In proposed method is mean square error compared with the equation is:

$$MSE = \frac{1}{hw}\sum_{p=1}^{h-1}\sum_{q=1}^{w-1}[y(p,q) - z(p,q)]^2 \quad (1)$$

Original image F, g is the uncompressed the image the image are two dimensions is m*n.

(b) Peak Signal to Noise Ratio

It is the ratio between the signals. The proposed method is compared with equation given:

$$PSNR = 10\,log_{10}\left(\frac{MAX}{\sqrt{MSE}}\right) \quad (2)$$

MAX is the maximum signal value

(c) Structural Similarity Index

It is used for measuring the similarity. SSIM index is measured full reference metric. The proposed method is compared with equation is given as:

$$SSIM = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k^2} \quad (3)$$

(d) Elapsed Time

It is duration from when the processing started until the time it terminated. It is a measure from start to end including time that passes due to process delays or waiting for value to become available. It equation is given as:

$$Elapsed\ Time = Finish\ Time - Start\ Time \quad (4)$$

Different denoising results have been shown in Figure 3 (a) Shows the original image for Satgravgrey. (b) Shows the result of Sparse Matrix Method and produced image divided some blocks image not show. (c) Shows the results of Bayes Thresholding Method image show very blurred. (d) Shows the result of Bilateral Filter image not clear show. (e) Noisy image obtained with proposed method.

From experimental results it has been concluded that the proposed method is best than existing method. From experimental results are shown. Graphical results of proposed work are as following.

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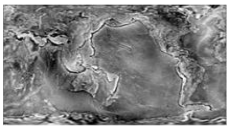
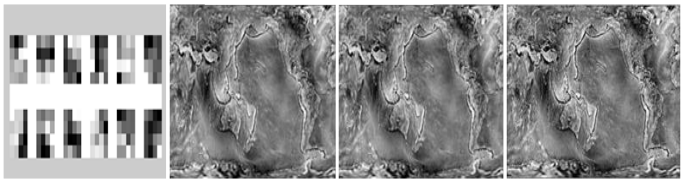


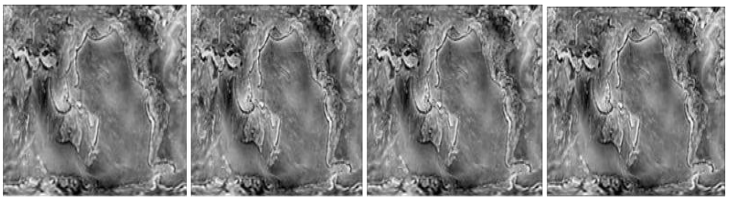
(a)



(b) (c) (d) (e)

Figure 3: Results for Satgravgrey image (a) Original image (b) Noisy image obtained with Sparse Matrix Method (c) Noisy image obtained with Bayes Thresholding Method (d) Noisy image obtained with Bilateral Filter (e) Noisy image obtained with Proposed Method.

After noise removal with different methods using Satgravgrey image is shown in Figure 4.



(a) (b) (c) (d)

Figure 4: Results for Satgravgrey image (a) Denoised image with Sparse Matrix Method (b) Denoised image with Bayes Thresholding Method (c) Denoised image with Bilateral Filter (d) Denoised image with Proposed Method.

Table 1

Comparison between Sparse Matrix Method, Bayes Thresholding Method, Bilateral Filter Method and Proposed Method in terms of PSNR, MSE, SSIM and Elapsed Time.

Parameters	Denoising Methods			
	Sparse Matrix Method	Bayes Thresholding Method	Bilateral Filter Method	Proposed Method
PSNR	21.82987	20.77318	22.76845	25.83711
MSE	93.76026	272.43483	181.72227	62.45477
SSIM	10.42476	1.04857	1.04904	10.41752
Elapsed Time(Sec)	2.577515	0.091368	0.083556	0.102527

Comparison of the Sparse Matrix method, Bayes Thresholding, Bilateral Filter and Proposed method in terms of PSNR, MSE, SSIM and Elapsed Time is shown in Table 1.

Comparison of the graphical representation of the proposed method with Sparse Matrix method, Bayes Thresholding and Bilateral Filter in terms of shown. PSNR is shown in Figure 5, In terms of MSE is shown in Figure 6 and in terms of SSIM is shown in Figure 7.

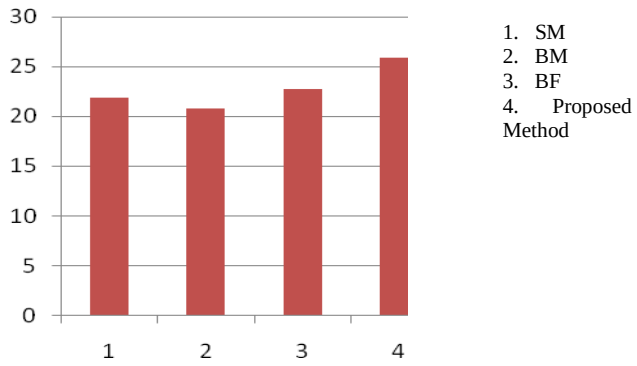


Figure 5: Comparison of the proposed methods with Sparse Matrix Method, Bayes Thresholding Method and Bilateral Filter Method in terms of Peak Signal to Noise Ratio using Satgravgrey image.

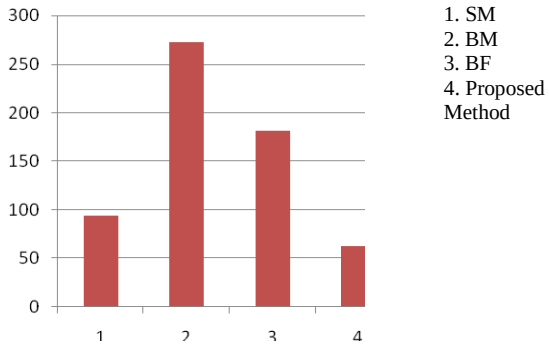


Figure 6: Comparison of the proposed methods with Sparse Matrix Method, Bayes Thresholding Method and Bilateral Filter Method in terms of Mean Square Error using Satgravgrey image.

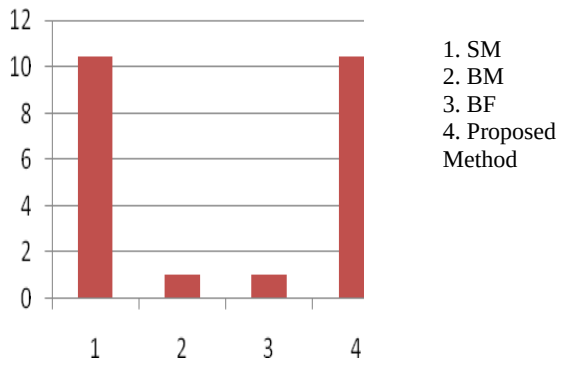


Figure 7: Comparison of the proposed methods with Sparse Matrix Method, Bayes Thresholding Method and Bilateral Filter Method in terms of Structural Similarity Index using Satgravgrey image.

V.CONCLUSION

In this paper various denoising methods are studied. In the proposed method Affinity matrix method is used to remove the noise from geographical images. Affinity matrix is used to find the similarity between pixels and traverse the image. Initial position in the pixels applied affinity matrix to compare the adjacent pixels of the image. It is calculates the probability of the pixel store in a matrix. A dissimilar pixel means unwanted or noisy pixels removed from the image as well as denoised the image. The performance of the proposed method is evaluated using Image Quality Measures (IQM) like Mean Square Error, Structural Similarity Index and Peak Signal to Noise Ratio etc. The proposed method is better than Sparse Matrix method, Bayes Thresholding method and Bilateral Filter in terms of MSE, PSNR and SSIM.

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