Australian Journal of Basic and Applied Sciences, 10(12) July 2016, Pages: 147-154

AUSTRALIAN JOURNAL OF BASIC AND APPLIED SCIENCES

ISSN:1991-8178 EISSN: 2309-8414
Journal home page: www.ajbasweb.com

Enhancement of satellite image using HierarchicalHistogram equalization with Denoising

[1]R. Shanmuga sundaram, [2]N. Santhiyakumari MIEEE, [3]P. Rajeswari MIEEE

[1]Assistant Professor, [2]Professor and Head, [3]PG Scholar Dept of ECE, Knowledge Institute of Technology, Salem, Tamilnadu, India - 637504

Address For Correspondence:
R. Shanmuga sundaram, Assistant Professor, Professor and Head, PG Scholar Dept of ECE, Knowledge Institute of Technology, Salem, Tamilnadu, India - 637504
E-mail: shanmugamme@rediffmail.com; +91 9751661542

ARTICLE INFO

Article history:
Received 26 April 2016
Accepted 21 July 2016
Published 30 July 2016

Keywords:
Directional filtering algorithm, Image denoising, Impulse noise, Histogram Equalization, satellite images, MSE, PSNR.

ABSTRACT

Image Denoising has a fundamental problem in the field of image processing. Noise removal is one of the complex tasks in pre-processing stages of image processing. One of the difficult tasks in the image processing is the removal of noise such as random valued impulse noise and salt and pepper noise. Different type's noises occurred in satellite image in the process of acquisition, transmission and receiving. The satellite images are degraded by the presence of noise sources. Noise hides vital features of image like edge and fine details. In order to get enhanced image, we present spatial non -linear filtering technique such as Directional Filtering algorithm. The proposed algorithm, divides the image into four directions and each direction has equal number of pixels, and then finds optimum direction. Then with the help of denoised image, enhanced image obtained from histogram equalization for improve visual quality. Performance of Enhancement is measured using quantitative performance measures such as peak signal-to-noise ratio (PSNR), Mean Square Error (MSE) as well as in terms of visual quality of the images using MATLAB.

INTRODUCTION

Digital Image Denoising is one of the greatest and challenging techniques in image research. Removing noise from images is interesting task in image processing problem, because edges which can also be displayed as immediate intensity jumps in a scan line are highly prominent features for visual consideration. Therefore, impulse noise removal is an central requirement for image denoising procedures .It should preserve significant image structures, such as edges and major texture features. The target of image Denoising is to improve the visual appearance of an image. Satellite images are widely used in the arena of RS and GIS for land possession, mapping use for planning and decision support. Many images like medical images, satellite images, aerial images and even real life photographs affected from poor contrast and noise.

It is needed to enhance the contrast and remove the noise to increase image quality. One of the most essential stages in satellite images detection and analysis is an image Denoising technique which recovers the quality of images for human viewing, removing blurring and noise, increasing contrast, etc. As of many Satellite image having common problem i.e. noise which hold unwanted information in an images. The need of Remote Sensing image Analysis is according to NASA, Temporal Resolution, and Weather Forecasting and Adjusting Contrast for Feature identification, Lagrangian, Animation, Channel combination and color enhancement.

Satellite images are usually degraded by noise during image acquisition and transmission process. The main purpose of the noise reduction technique is to remove impulse noise by retaining the important feature of the images. For example, Synthetic Aperture Radar (SAR) imagery uses microwave radiation so that it can

To Cite This Article: R. Shanmuga sundaram, N. Santhiyakumari MIEEE, P. Rajeswari MIEEE., Enhancement of satellite image using HierarchicalHistogram equalization with Denoising. ***Aust. J. Basic & Appl. Sci.,*** *10(12): 147-154, 2016*

illuminate the earth surface. Synthetic Aperture Radar provides its own illumination. The intensity of impulse noise has the tendency of being either relatively high or low thereby causing loss of image details. It is important to eliminate noise in images before using them for other image processing techniques like edge detection, segmentation, and registration.

In (Ajay, G. Anand Kumar, 2014), the noised images from multiple sensors can be combined into a single image by using Fusion algorithm. The Impulse noise that effects the fused image can be removed by using Wavelet transform technique.Bhosale Narayan P et al., (2014) explained the wavelet transform in Denoising. The transform allows representation of a signal onto an orthonormal basis. Each term of the basis represents the signal at a given scale. In order to decompose the signal onto the basis, the algorithm developedand which is applied to the signal. It consists of iterations of one-dimensional high pass and low-pass filtering steps. The algorithm creates a pyramid of low-resolution approximations as well as a wavelet pyramid in which the details a stored as wavelet coefficients.

Dimitri Van De Ville et al., (2003) described the fuzzy image filter can be applied iteratively to effectively reduce heavy noise. In particular, the shape of the membership functions is adapted according to the remaining noise level after each iteration, making use of the distribution of the homogeneity in the image.Geeta Hanji et al., (2014) described Noise Exclusion median filter. In order to restore the faulty pixels, the proposed algorithm uses the Noise Exclusive Median (NEM) which is computed as the median of already processed pixels from the current window.

Harikiran et al., (2010) explained the Image fusion technique to remove impulse noise. It is the process of combining two or more images into a single image while retaining the important features of each image. Based on probability of pixel which can classify as noisy or noiseless pixel. Then filtered images are fused to obtain high quality image. Jian-Feng Cai et al., (2010) described a two-phase approach to restore images corrupted by blur and impulse noise. In the first phase, we identify the outlier candidates the pixels that are likely to be corrupted by impulse noise. We consider that the remaining data pixels are essentially free of outliers. Then in the second phase, the image is deplored and Denoised simultaneously by a variation method by using the essentially outlier-free data.

Manohar Koli1 et al., (2014) proposed an algorithm which contains two phases such as detects the noisy pixels and replaces identified noisy pixels by non-noisy estimated values Restored Mean Absolute Error (RMAE) is used to measure and compare the performance of the proposed algorithm and also to controls the flow of noise signal and produces consistent and very high quality output. Pushpavalli et al., (2012) integrating two decision based filters with switching scheme. This technique is used to detect and reduce the impulse noise on digital images. Tristate Switching Median Filtering Technique is proposed for digital images which are degraded by salt and pepper noise.

Praveen Kumar et al., (2013) the fuzzy based filter which performs the highest PSNR rate rather than the other type of filters. The first stage computes a fuzzy derivative for eight different directions. The second stage uses these fuzzy derivatives to perform fuzzy smoothing by weighting the contributions of neigh boring pixel value. Richard Alan Peters et al., (1995) Morphological openings and closings are useful for the smoothing of gray scale images. Image noise reduction is limited by their tendency to remove important, thin features from an image along with the noise. The morphological image cleaning algorithm (MIC) that preserves thin features while removing noise.

Suman et al., (2014) presents median based filter for eliminating noisy pixels. The filtering techniques are applied through several iterations to ensure that all the noisy pixels have be detected in the case when the image is highly corrupted and the corrupted pixels have been filtered using adaptive based median method.Trahanias et al., (1993) Vector directional filters (VDF) for multichannel image processing filters to separate the processing of vector-valued signals into directional processing and magnitude processing. This provides a link between single-channel image processing, where only magnitude processing is essentially performed, and multichannel image processing where both the direction and the magnitude of the image vectors.

Tao Chen et al., (2015) propose adaptive operator which forms estimates based on the differences between the current pixel and the outputs of center-weighted median (CWM) filters with varied center weights. To utilize the center-weighted median (CWM) filters that have varied center weights to define a more general operator, which realizes the impulse detection by using the differences, defined between the outputs of CWM filters and the current pixel of concern. The ultimate output is switched between the median and the current pixel itself. While still using asimple thresholding operation, the proposed filter yields superior results to other switching schemes in suppressing both types of impulses with different noise ratios.

Umesh Ghanekar et al., (2010) suggest adaptive threshold to remove noise from the images. The detection of noisy pixels is based on an adaptive threshold which is dependent on the local statistics in the filtering window. The filtering method corrects only the corrupted pixel values by taking into consideration the brightness and colour information for restoration of noisy images. Vishnu Praksh.M et al., (2015) propose decision based algorithm is dependent on noise density. First calculate the noise density of corrupted image then followed by noise detection and filtering. Noise density an increase, the window size is increased which gives better results. In that replaces the pixels with values 0 and 255 with the median of the window considered if the window also includes pixel values other than 0 or 255.

Zhou Wang et al., presents median- based filter. The progressive switching median (PSM) filter is proposed to restore images corrupted by salt– pepper impulse noise. The algorithm is developed by the following two main points: 1) switching scheme—an impulse detection algorithm is used before filtering, thus only a proportion of all the pixels will be filtered and 2) progressive methods—both the impulse detection and the noise filtering procedures are progressively applied through several iterations.

In this work, we use directional median filter which employs impulse detection mechanism. The ultimate output is switched between the median and the current pixel itself. While still using a simple thresholding operation, the proposed filter yields superior results to other switching schemes in suppressing both types of impulses with different noise ratios.

II Methodology:

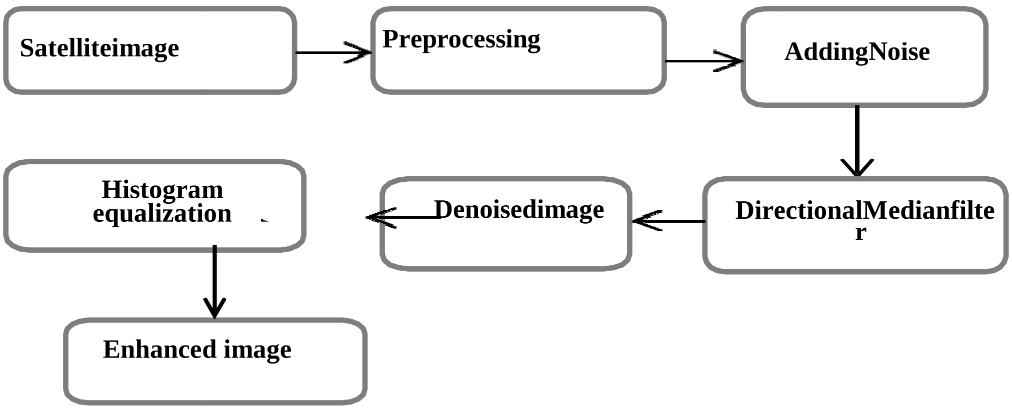

Fig. 1: Block Diagram for enhancing image

Proposed method is using a median algorithm based on estimating the optimal direction used to measure if the tested pixel is noisy or noise-free pixel. if the accurate or optimal direction of the edge is determined then more edge pixels can be detected. The noisy pixel that has small deviations with the pixels in the optimal direction is defined an original pixel. Noisy pixel is calculated by similarity parameter. Then, compute PSNR, MSE values for various noise values.

III. Proposed Method:

The noises in the satellite image are detected and removed using the following algorithm:

Optimum Edge preserving impulse noise removing algorithm:

Step 1 : For each current pixel, take k*k neighboring window W.
Step 2 : Divide W into four directional vectors.
Step 3 : Remove the current pixel under process from the selected directional vectors.
Step 4 : Sort each vectors and remove the lowest and highest elements.
Step 5 : Find the standard deviation for each vectors.
Step 6 :Find the minimum of 4 standard deviations and the corresponding direction is considered as optimum direction.
Step 7 : Calculate the similarity parameter S between the current pixel under the process and the pixels in the optimum direction.
Step 8 : Set the threshold T and classify the current pixel under process is either original or noisy pixel.
Step 9 : Restore the corrupted noisy pixels only by using median filtering.
Step 10: Repeat the steps 1:9 to get new image with better visual quality

III.Aformulation:

In this Algorithm, the filtering window is separated into four directions. Individual direction has an equal number of pixels. These pixels may be placed in a smooth area or on an edge. The key point is to find the optimal direction to be used as a reference, or a scale to determine whether the tested pixel is noisy or noise-free pixel. The optimal direction is the direction which has the most similar pixels. Hence, for each pixel to be refereed as an original, it should ensure small deviations with the pixels in the optimal direction.

Australian Journal of Basic and Applied Sciences, 10(12) July 2016, Pages: 147-154

The proposed algorithm may be described as follows

1) In a k × k window, the first pixel is denoted byx_{ij}, then the total pixels in the window, except the central pixel Xi+(k+1)/2,j+(k+1)/2,are divided into four directions $D^{ij}_{d,s}$, d=1:4 for a window of 9x9 size, and a first pixel $x_{0,0}$ the pixels in each direction are scheduled in terms of their coordinates as follows:

$\boldsymbol{D_1^{0,0}}$={(0,0),(1,1),(2,2),(3,3),(5,5),(6,6),(7,7),(8,8)}
$\boldsymbol{D_2^{0,0}}$={(0,8),(1,1),(2,2),(3,3),(5,5),(6,2),(7,7),(8,8)}
$\boldsymbol{D_3^{0,0}}$={(0,4),(1,4),(2,4),(3,4),(5,4),(6,4),(7,4),(8,4)}
$\boldsymbol{D_4^{0,0}}$={(4,0),(4,1),(4,2),(4,3),(4,5),(4,6),(4,7),(4,8)}

2) After that, rejecting the current pixel from all vectors in each direction $\boldsymbol{D_d^{ij}}$,then it is arranged in ascending order, so that removing highest and lowest pixel. Obtain the new vector $\boldsymbol{r_d^{ij}}$ (d = 1:4) from the corresponding sorted direction $\boldsymbol{D_d^{ij}}$ is defined as

$$\boldsymbol{r_d^{ij} = x_d^{1,s} \in D_d^{ij}, s = 1: k-1, d = 1: \geq x_{1,s}} \quad (3.1)$$

3) For every direction the smallest and the largest pixels are expected to be outliers, and so they are removed. Hence, a new vector $\boldsymbol{\tilde{r}_d^{ij}}$of lower elements is defined as

$$\boldsymbol{\tilde{r}_d^{ij} = \left\{x_{1,s}^d \middle| s = 2: k-2, d = 1: 4\right\}} \quad (3.2)$$

4) Finding the standard deviations and calculating optimum direction $\boldsymbol{D^{op}}$ by resulting the vector $\boldsymbol{\tilde{r}_d^{ij}}$that has the minimum standard deviation:

Optimum Direction ($\boldsymbol{D^{op}}$) = argmin (stdAllDir)

$$\boldsymbol{D^{op}} = \text{argmin } \{\boldsymbol{\sigma_{\tilde{r}_d^{ij}}}\} \quad (3.3)$$

$\boldsymbol{\sigma_{\tilde{r}_d^{ij}}}$ is the standard deviation of the pixels in the vector $\boldsymbol{r_d^{ij}}$ Equation (3.3) means that the optimum direction is the direction that has the most similar pixels.

5)By using the central pixel Xi+(k+1)/2,j+(k+1)/2 whether it is noisy or noise-free pixel, a similarity parameter S is determined by quantifying the normalized distance between the tested pixel, and the pixels in the optimal direction. By denoting the subscript i + (k+1) / 2 by $\boldsymbol{\tilde{\imath}}$ and j + (k+1) / 2 by $\boldsymbol{\tilde{\jmath}}$ is defined as

$$\boldsymbol{s = \sum_{s=2}^{k-2} \left|\frac{x_{1,s}^{op} - x_{\tilde{\imath}\tilde{\jmath}}}{255}\right|} \quad (3.4)$$

Where $\boldsymbol{x_{1,s}^{op}}$ is the pixel S in the optimal direction.

6) By using a suitable threshold, can choose if the tested pixel is a noisy $\boldsymbol{x_{no}}$or an original pixel $\boldsymbol{x_{or}}$.Also, it is in the range of $[\boldsymbol{0, k-3}]$ which is the bounds of. Thus,

$$\boldsymbol{x_{\tilde{\imath}\tilde{\jmath}}} = \begin{cases} \boldsymbol{x_{no}}, & \boldsymbol{if\ S < T, \{0 \leq T \leq K-3\}} \\ \boldsymbol{x_{or}}, & \boldsymbol{else} \end{cases} \quad (3.5)$$

Value of threshold T should have close to zero. The cause is that the tested pixel to be considered as an original should be similar to the pixels in the optimum direction, or lead to a small value of. The central pixel is labeled as 1 in a binary image, if it is identified as an original pixel, and flagged as 0, if it is detected as a noisy pixel. Immediately detected noisy pixel is eliminated and is not involved in the detection process any more.

7) After detecting all pixels in the noisy image, the restoration process for getting the first restored image begins. Any pixel labeled as 0 by switching it by the median of its good neighboring pixels. Pixels between the neighboring ones that flagged as 0, and not restored yet, are excluded from the restoration process.

Thus, the restored pixel $\boldsymbol{x_{i,j}^{rest}}$ is given by

$$\boldsymbol{x_{\tilde{\imath},\tilde{\jmath}}^{rest}} = \boldsymbol{median(x_{\tilde{\imath}+s,\tilde{\jmath}+t}\{0 \leq s, t \leq (k-1)\})} \quad (3.6)$$

Australian Journal of Basic and Applied Sciences, 10(12) July 2016, Pages: 147-154

8) The previous steps are implemented again on the first restored image, so that we can get a new restored image with better visual quality. Also, the closest four pixels are preferable to be used in the second restoration process for estimating the noisy pixel. The first detection process is used to removing the impulse noise that has sharp intensity values, while the second one is used for removing the impulse noise that has somewhat small differences with the pixels in the optimum direction. Thus, we use a threshold T1 of higher value in the first iteration, and a threshold T2 in the second iteration. The window size should be large enough, particularly at high noise rates to avoid finding an empty direction that is out of pixels (all its pixels are detected as noisy pixels). In the case of empty direction, it is difficult to determine the optimal direction.

Local Histogram Equalization:

Histogram equalization is a method used to increase contrast in face images. It differs from ordinary histogram equalization with respect that the Local method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values o.

f the image. Histogram Equalization is applied on the entire image. Local Histogram Equalization is applied on the 3*3 over lapped block on the whole image. Below figure shows the Histogram equalization. Replace 0,1..255 by this cumulative histogram value. This is called Histogram equalization.

4	2	3
3	5	3
2	1	1

Pixel value	Histogram count	Cumulative histogram
0	0	0
1	2	2
2	2	4
3	3	7
4	1	8
5	1	9
.		
.		
255	0	

Fig. 2: Histogram equalization

For each pixel on an image, we do the histogram equalization on the local w-by-h window centering on this pixel using:

$$f(x) = round\left[\frac{cdf(x)-cdf_{min}}{w.h-cdf_{min}}.(L-1)\right] \quad (3.7)$$

where x is the pixel intensity value, cd f (x) is the cumulative distribution function of the histogram of the pixel intensities in the w-by-h window, cdf_{min} is the minimum intensity in this window, and L is the desired number of output gray levels=256. Typically a square window is used, and we define k ≡ w = h. Call the center of the k-by-k window the anchor. For LHE, the anchor point is the pixel to be processed itself. For the entire image, each pixel reiterations the above operation and uses f (x) to develop its new intensity value.

III.B.Performanceevalution:

Image quality Measurement is an essential for many image processing applications .Image quality assessment is narrowly related to image similarity assessment in which quality is calculated based on the differences (or similarity) between a corrupted image and the unmodified image.

Quality has been estimated in terms of familiar metrics such as

1. Mean Squared Error (MSE)
2. Peak Signal to Noise Ratio (PSNR)

1. Mean Squared Error (MSE)

It refers the mean squared difference between the original image and inaccurate image. The mathematical definition for MSE is

$$MSE=(1/M*N)\sum_{i=1}^{M}\sum_{j=1}^{N}(a_{ij}-b_{ij})^2 \quad (3.7)$$

2. Peak Signal to Noise Ratio (PSNR)

PSNR is a defined as the ratio between the maximum possible power of a signal and the Power of evaluating noise that disturbs the fidelity of its representation.

It is given by

$$PSNR = 10\, log_{10}\, 255^2/MSE \quad (3.8)$$

Australian Journal of Basic and Applied Sciences, 10(12) July 2016, Pages: 147-154

Where 255 is the maximal possible value of the image pixels.

Types of filter	PSNR for 20%
Adaptive median filter	33.44
Discrete wavelets	21.12
Continuous wavelets	21.99
Fuzzy based filter	44.05
Proposed	90.91

Fig. 3: Performance analysis table

RESULTS AND DISCUSSION

Performance of the proposed directional median filter Scheme is validated with the MATLAB simulation performed on satellite images with impulsive noise. At various noise densities the PSNR values are calculated. Then the performance table shows the improved PSNR value for proposed algorithm when compared to other methods. Finally histogram was performed to get better enhanced image.

Fig. 5: Original satellite image

Fig. 8: Noisy satellite image

Fig. 7: Noise free image

Australian Journal of Basic and Applied Sciences, 10(12) July 2016, Pages: 147-154

Fig. 8: Enhanced image

Conclusion:

In this paper, the remote sensing satellite image is denoised and then enhanced. The random impulse noise removal algorithm is used to detect and remove the random noises from the satellite images. Next, the oriented hierarchical local histogram equalization (HHE) technique is applied on the denoised image to enhance the pixel intensities at the edges. The proposed method achieved better PSNR as image quality estimation parameter and provided improved MSE. The proposed method works well on both low and high resolution satelliteimages.

REFERENCES

Ajay, G. Anand Kumar, 2014. " Removal of Impulse Noise from Remote Sensing Images Using Wavelets Based on Image Fusion Algorithm", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, , ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875, 3: 9.

Bhosale Narayan, P., R. Ramesh Manza, K.V. Kale, 2014. " Image Denoising Based On Wavelet for Satellite Imagery", International Journal Of Modern Engineering Research (IJMER), ISSN: 2249-6645, 4: 4.

Dimitri Van De Ville, Wilfried Philips, 2003." Noise Reduction by Fuzzy Image Filtering", IEEE Transactions On Fuzzy Systems, 11: 4.

Geeta Hanji and M.V. Latte, 2014. "Novel Adaptive Filter (NAF) for Impulse Noise Suppression from Digital Images", International Journal on Bioinformatics & Biosciences (IJBB) 4: 3/4.

Harikiran B. Saichandana B. Divakar, 2010. "Impulse Noise Removal in Digital Images", International Journal of Computer Applications (0975 – 8887) 10: 8.

Jian-Feng Cai, Raymond H. Chan, Mila Nikolova, 2010. "Fast Two-Phase Image Deblurring under Impulse Noise", J Math Imaging Vis., 36: 46–53 DOI 10.1007/s10851-009-0169-7.

Manohar Koli, and S. Balaji, 2014. "High Density Salt and Pepper Impulse Noise Removal", ACEEE Int. J. on Signal and Image Processing, 5: 1.

Pushpavalli and G. Sivaradje, 2012. "A New Tristate Switching Median Filtering Technique for Image Enhancement", International Journal of Advanced Research in Engineering and Technology (IJARET), ISSN 0976 - 6480 (Print) ISSN 0976 - 6499 (Online) 3(1): 55-65.

Praveen Kumar, B.T., Dr. R. Vijayakumar, 2013." Comparisons of adaptive median filter based on homogeneity level information and the new generation filters", IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p- ISSN: 2278-8727 14(3): 01-05.

Richard Alan Peters, 1995. "A New Algorithm for Image Noise Reduction using Mathematical Morphology", IEEE Transactions on Image Processing, 4(3): 554-568.

Suman Shrestha, 2014. "Image Denoising Using New Adaptive Based Median Filter", Signal & Image Processing: An International Journal (SIPIJ) 5: 4.

Trahanias and A.N. Venetsanopoulos, 1993. "Vector Directional Filter-A New Class of Multichannel Image Processing Filters", IEEE Transactions on Image Processing, 2: 4.

Trapti Soni, Narendra Rathor, 2015. "Removal of High Density Impulse Noise using Efficient Median Filter for Digital Image", International Journal of Computer Applications (0975 – 8887) 115: 5.

Tao Chen and Hong Ren Wu, 2001. "Adaptive Impulse Detection Using Center-Weighted Median Filters", IEEE Signal Processing Letters, 8: 1.

Umesh Ghanekar, Awadhesh Kumar Singh, and Rajoo Pandey, 2010. " Random Valued Impulse Noise Removal in Colour Images using Adaptive Threshold and Colour Correction", ACEEE Int. J. on Signal & Image Processing, 01: 03.

Vishnu Praksh, M., K. Shreedarshan, 2015. “An Efficient Noise Removal Algorithm Based on the Noise Density”, International Journal on Advanced Trends in Computer Science and Engineering (IJATCSE), ISSN 2278 – 3091, 4(1): 01-05.