ISSN: 2321-7782 (Online)
Volume 2, Issue 1, January 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Paper
Available online at: www.ijarcsms.com

Design of Denoising Algorithm for Removal of Impulse Noise in Image

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Abstract: A new framework proposes to remove the high density impulse noise from the digital images using spatial filtering techniques. Here, the performance will be compared between decision based un symmetric trimmed median filter and previous non linear filters. In the Transmission of images over channels, Images are corrupted by impulse noise, due to faulty communications. Impulse noise is also referred to as Salt and pepper noise. The aim of filtering is to remove the impulses so that the noise free image is fully recovered with minimum signal distortion. The best and most widely used non-linear digital filters are median filters. Median filters are known for their potential to remove impulse noise without damaging the edges. Adaptive Median is a "decision-based" or "switching" filter that first identifies possible noisy pixels and then replaces them using the median filter, while leaving all other pixels unchanged. This filter is excellent at detecting noise even at a high noise level. The adaptive structure of this filter fortify that the impulse noises are detected even at a high noise level provided that the Window size is large enough. The accessible non-linear filter like Standard Median Filter (SMF), Adaptive Median Filter (AMF), Decision Based Algorithm (DBA) and Robust Estimation Algorithm (REA) shows better results at low and medium noise densities. At high noise density, their performance is deprived. A new algorithm to remove high-density impulse noise using Decision Based UN Symmetric Trimmed Median Filter (DBUTM) is used.

Keywords: DBUTM filter, image denoising, impulse detector.

I. INTRODUCTION

IMPULSE noise in images is available because of spot lapses in transmission or presented throughout the indicator obtaining stage. There are two sorts of motivation clamor, they are salt and pepper commotion and arbitrary esteemed clamor. Salt and pepper clamor can degenerate the pictures where the adulterated pixel takes either most extreme or least light black level. Some nonlinear channels have been proposed for restoration of pictures defiled by salt and pepper clamor. Around this standard average channel has been created as dependable system to evacuate the salt and pepper clamor without harming the edge items. Nonetheless, the significant impairment of standard Median Filter (MF) is that the channel is compelling just at low commotion densities .When the clamor level is over half the edge parts of the definitive picture won't be protected by standard average channel. Vector Median Filter (VMF) performs well at low commotion densities. At the same time at high clamor densities the window size must be expanded which may accelerate smudging the picture. In exchanging average channel the choice is dependent upon predefined limit esteem. The significant burden of this technique is that characterizing a powerful choice is challenging. Likewise these channels won't consider the nearby characteristics as an aftereffect of which portions and edges may not be recuperated acceptably, particularly when the clamor level is high. To beat the above inconvenience, Spatial Median Filter (SMF) is proposed. In this, picture is denoised by utilizing a 3x3 window. In the event that the transforming pixel worth is 0 or 255 it is prepared or else it is left unaltered. At high clamor thickness the average worth will be 0 or 255 which is uproarious. In such case, neighboring pixel is utilized for swap. This rehashed reinstatement of neighboring pixel produces streaking impact. To maintain a strategic distance from this disadvantage, Decision Based UN symmetric Trimmed Median Filter (DBUTMF) is proposed. At high clamor densities, if the chose window holds every one of the 0's or 255's or both then, trimmed average quality can't be gotten. So this calculation improves not give results at quite high commotion thickness that is at 80% to 90%. The proposed Modified Decision Based UN symmetric Trimmed Median Filter (MDBUTMF) calculation evacuates this detriment at high clamor thickness and gives better Peak Signal-to-Noise Ratio (PSNR) values than the existing calculation. Whatever is left of the paper is organized as takes after. A concise presentation of Unsymmertric trimmed average channel is given in Section II. Segment III depicts about the proposed calculation and diverse instances of proposed calculation. The definite depiction of the proposed calculation with a sample is exhibited in Section IV. Recreation results with distinctive pictures are introduced in Section V. At last conclusions are attracted Section VI.

II. UN SYMMETRIC TRIMMED MEDIAN FILTER

The thought behind a trimmed channel is to reject the boisterous pixel from the chose 3x 3window.alpha Trimmed Mean Filtering (ATMF) is a symmetrical channel where uncorrupted pixels are likewise trimmed. This accelerates misfortune of picture parts and obscuring of the picture. Keeping in mind the end goal to conquer this detriment, an Unsymmetric Trimmed Median Filter (UTMF) is proposed. In this UTMF, the chose 3x3 window components are orchestrated in either expanding or diminishing request. At that point the pixel values 0's and 255's in the picture (i.e., the pixel values answerable for the salt and pepper clamor) are evacuated from the picture. At that point the average quality of the remaining pixels is taken. This average quality is utilized to trade the loud pixel. This channel is called trimmed average channel in light of the fact that the pixel values 0's and 255's are uprooted from the chose window. This strategy evacuates commotion in preferred path over the ATMF.

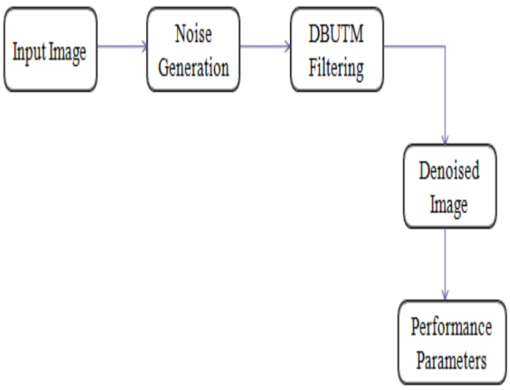

Figure 1 Block Diagram

III. NOISE GENERATION

Consider set of images containing various amounts of artificial noise. Impulse noise represents random spikes of energy that happen during the data transfer of an image. To generate noise, a percentage of the image is damaged by changing a randomly selected point channel to a random value from 0 to 255. The noise model, I_n is given by

$$I_n(i, j) = \begin{cases} I(i, j) & x \geq p \\ (I_r(i, j), I_g(i, j), z) \quad y < \frac{1}{3} & x < p \\ (I_r(i, j), z, I_b(i, j)) \quad \frac{1}{3} \leq y < \frac{1}{3} & x < p \\ (z, Ig(i, j), I_b(i, j)) \quad \frac{2}{3} \leq y & x < p \end{cases} \qquad (1)$$

where *I* is the original image, *Ir*, *Ig*, and *Ib* represent the original red, green, and blue component intensities of the original image, *x*,*y*= [0,1] are continuous uniform random numbers, *z*= [0,255] is a discrete uniform random number, and *p* = [0,1] is a parameter which represents the probability of noise in the image.

IV. Design Based Un symmetric Trimmed median Filter

It is a process to reject the noisy pixel from the selected 3* 3window.Alpha Trimmed Mean Filtering is a symmetrical filter where the trimming is symmetric at either end. In this procedure, even the unaffected pixels are also trimmed. This leads to loss of image information and blurring of the image. In order to overcome this problem, an Un symmetric Trimmed Median Filter (UTMF) is proposed. In this the selected 3* 3 window pixels are arranged in either increasing or decreasing order. Then the pixel value 0's and 255's in the image (i.e., the pixel values responsible for the salt and pepper noise) are removed from the image. Then the median values of the remaining pixels are taken. These median values are used as filter because the pixel values 0's and 255's is removed from the selected window. This procedure removes noise in enhanced way than the ATMF.

The processing pixel is checked whether it is noisy or noisy free. That is, if the processing pixel slur between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the dispensation pixel takes the maximum or minimum gray level then it is noisy pixel which is processed by DBUTMF

Algorithm

Step 1: Select 2-D window of size 3x3. Assume that the pixel being processed is $\mathbf{P_{ij}}$.

Step 2: If $0<\mathbf{P_{ij}}<255$ then P_{ij} is an uncorrupted pixel and its value is left unchanged.

Step 3: If $\mathbf{P_{ij}}=0$ or $\mathbf{P_{ij}}=255$ then $\mathbf{P_{ij}}$ is a corrupted pixel then two cases are possible as given in Case i) and ii).

Case i): If the selected window contains all the elements as 0's and 255's, then replace $\mathbf{P_{ij}}$ with the mean of the element of window.

Case ii): If the selected window contains not all elements as 0's and 255's,then eliminate 255's and 0's and find the median value of the remaining elements, replace $\mathbf{P_{ij}}$ with the median value.

Step 4: Repeat steps 1 to 3 until all the pixels in the entire image are processed.

V. Outline of DBUTMF Algorithm

Every last pixel of the picture is checked for the vicinity of salt and pepper clamor. Diverse cases are represented in this Section. Assuming that the handling pixel is uproarious and all other pixel qualities are either 0's or 255's is shown in Case i). In the event that the handling pixel is loud pixel that is 0 or 255 is represented in Case ii). Assuming that the handling pixel is not boisterous pixel and its esteem lies between 0 and 255 is delineated in Case iii).

Case i): If the chose window holds salt/pepper clamor as preparing pixel (i.e., 255/0 pixel esteem) and neighboring pixel qualities holds all pixels that adds salt and pepper commotion to the picture:

$$\begin{pmatrix} 0 & 255 & 0 \\ 0 & (255) & 255 \\ 255 & 0 & 255 \end{pmatrix}$$

where "255" is preparing pixel, i.e.,. $(\mathbf{P_{ij}})^{\cdot}$

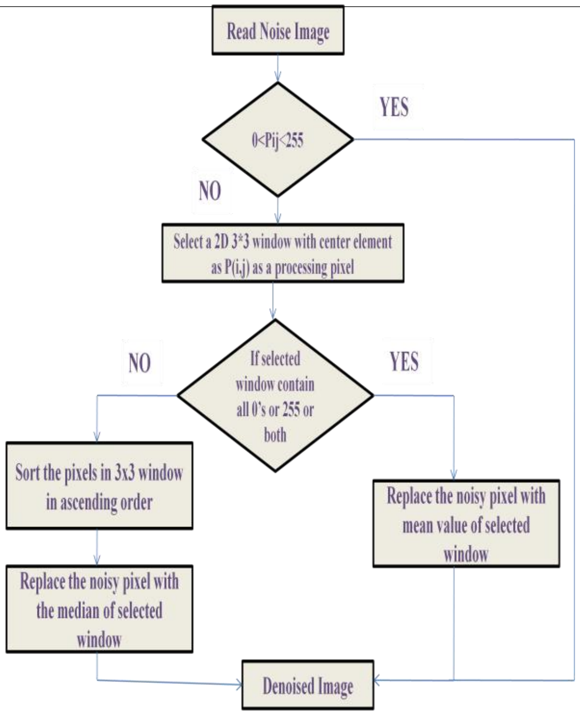

Figure 2 Flowchart for DBUTM

Since all the components encompassing **(P_{ij})** are 0's and 255's. Assuming that one takes the average worth it will be either 0 or 255 which is again uproarious. To comprehend this

Case ii): If they chose window holds salt or pepper commotion as transforming pixel (i.e., 255/0 pixel esteem) and neighboring pixel qualities holds a few pixels that includes salt (i.e., 255 pixel esteem) and pepper clamor to the picture:

Noise in %	Mean	Median	SMF	VMF	DBUTM
10	30.54	39.03	33.25	37.66	48.21
20	29.26	37.99	32.82	36.42	45.23
30	28.70	36.80	32.40	34.71	45.24
40	28.46	35.30	32.15	32.59	40.91
50	28.28	33.73	31.58	30.52	39.31
60	28.10	32.07	30.80	28.82	37.45
70	27.98	30.65	29.99	27.60	34.83
80	27.90	29.24	28.90	26.82	31.45
90	27.80	28.04	28.14	26.53	27.81

$$\begin{pmatrix} 78 & 90 & 0 \\ 120 & (0) & 255 \\ 97 & 255 & 73 \end{pmatrix}$$

Case iii): If the chose window holds a clamor free pixel as a handling pixel, it doesn't oblige further preparing. For instance, if the preparing pixel is 90 then it is clamor free pixel:

$$\begin{pmatrix} 43 & 67 & 70 \\ 55 & (90) & 79 \\ 85 & 81 & 66 \end{pmatrix}$$

where "90" is handling pixel, i.e., Since "90" is a commotion free pixel it does not oblige further processing

VI. PERFORMANCE EVALUATION

To test the accuracy of the TMF, we need three things: an uncorrupted image, the image with corruption applied by some means, and the estimated reconstruction of the original by the spatial median filter. To estimate the quality of a reconstructed image, The Quality of the reconstructed image is measured in terms of mean square error (MSE) and peak signal to noise ratio (PSNR) ratio. The MSE is often called reconstruction error variance σ_q^2. The MSE between the original image f and the reconstructed image g at decoder is defined as:

$$MSE = 1/N \sum_{j,k} (f[j,k] - g[j,k])^2 \qquad (2)$$

Where the sum over j, k denotes the sum over all pixels in the image and N is the number of pixels in each image. From that the peak signal-to-noise ratio is defined as the ratio between signal variance and reconstruction error variance. The PSNR between two images having 8 bits per pixel in terms of decibels (dBs) is given by

$$PSNR = 10 \log_{10} \left(\frac{255^2}{MSE} \right) \qquad (3)$$

VII. SIMULATION RESULTS

The execution of the proposed calculation is tried with distinctive light black scale and shade pictures. The commotion thickness (power) is changed from 10% to 90% Denoising execution quantatively measured by MSE and PSNR as characterized in (2) and (3), individually

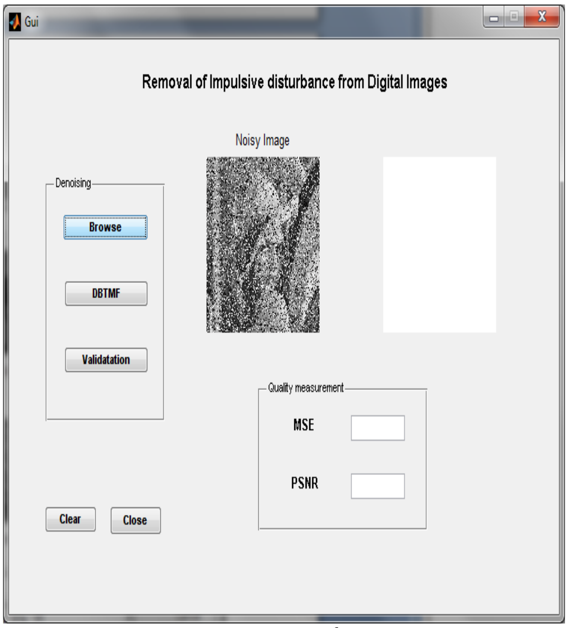

Figure 3 Generation of noise

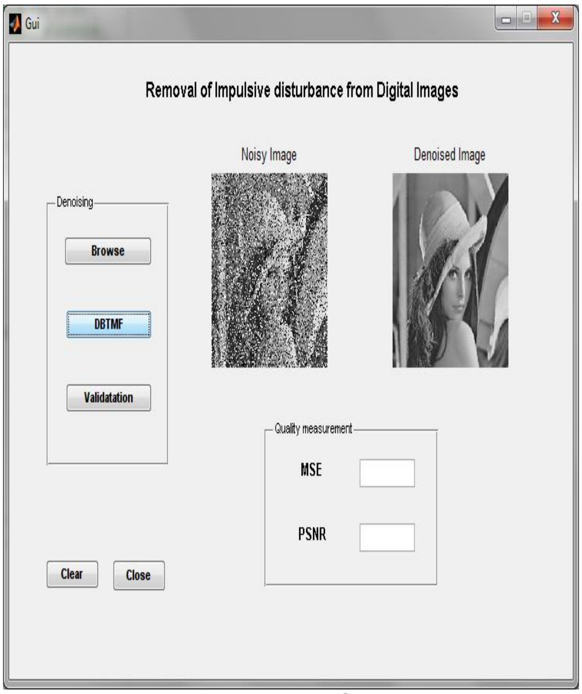

Figure 4 Denoised image

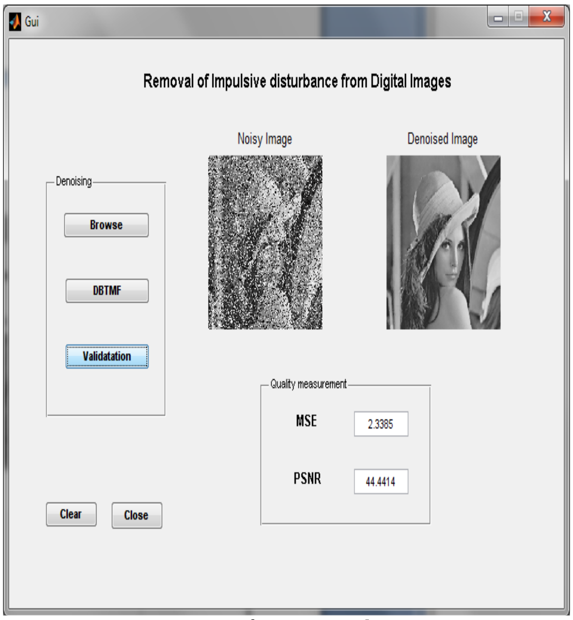

Figure 5 Performance Evaluation

VIII. Conclusion

A new algorithm DBUTMF is proposed which gives better performance in comparison with MF, AMF and other existing noise removal algorithms. The proposed algorithm gives better performance in comparison with existing impulse noise removal algorithms in terms of PSNR. The performance of the algorithm has been tested at low, medium and high noise densities on gray-scale images. Even at high noise density levels the DBUTMF gives better results in comparison with other existing algorithms. Both visual and quantitative results are demonstrated. The proposed algorithm is effective for impulse noise removal in images at high noise densities.

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