www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 4 April 2015, Page No. 11553-11557

Comparative Performance Analysis of Removal of Impulse Noise using Different Methods

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Abstract: ***In this research paper we have introduced a comparative performance analysis of the removal of random valued impulse noise using different filters. Removal of random valued impulse noise in digital images with edge preservation is one of the challenging tasks in digital image processing. For elimination of noise from digital images plays a vital role. Effective detection of noisy pixel based on median value and an efficient algorithm for the estimation and replacement of noisy pixel has been carried out in different comparative methods in this paper. Here we have compare a different type of de-noising algorithms they are - Median filter (MF) [4], Centre weighted median filter (CWM) [6] [15], Progressive switching median filter (PSMF) [12], Signal dependent rank order median filter (SDROM) [9] [14], Adaptive center weighted median filter (ACWM) [10] [11], (ACWMF), Tristate median filter (TSM) [13]. The presence of high performing detection stage for the detection noisy pixel makes the proposed method suitable in the case of high density random valued impulse noise. Here we have compare different method on the basis of PSNR and MSE values.***

Keywords: Mean square error, Peak signal to noise ratio, Median filter, Random valued impulse noise.

1. Introduction

Digital picture throughout during of image acquisition or transmission has forever been a really cumbersome task for researchers. In the field of image process, digital pictures fairly often get corrupted by many sorts of noise throughout the method of image acquisition. The essential reasons are defective of pixels in private sensors, faulty memory locations in hardware, or transmission during a crying channel [1]. Pictures are typically corrupted by the impulse noise, Gaussian noise, shot noise, speckle noise, etc. Preservation of image details and suppression of noise are the 2 necessary aspects of image process. Typically impulse noise is assessed into 2 types: called the fastened valued impulse noise and also the random-valued impulse noise. Here during this paper, we tend to specialize in random valued impulse noise. Random valued impulse noise generates impulses whose grey level value lies inside a particular vary. The random worth impulse noise lies between zero and 255 and it's terribly troublesome to get rid of this noise. Salt and pepper noise is additionally called fastened valued impulse noise manufacturing two grey level values zero and 255. Wherever zero values belong to black and 255 belongs to white on the grey scale. It is typically mirrored by pixels having minimum and most worth during a grayscale image. typically the essential plan behind image de-noising is that the detection stage, that identifies the crying and noise free pixels of the corrupted image, afterward noise removal half removes the noise from the corrupted image below method whereas protective the opposite necessary detail of image.

There are 2 forms of filters in spatial domain: linear filter and non-linear filter. Linear filters are unit like wiener filter, mean filter. Here we tend to propose a nonlinear median filter that removes random valued noise and preserves the perimeters of the image.

Initially normal median filter was used, however in a while switch primarily based median filters were developed that provides higher results. The other result orienting normal median filters were developed, like weighted median filter, SDROM filter [8], Centre weighted median filter [14], adaptive median filter, rank conditioned rank selection filter [12] and plenty of different improved filters. The results of median filter additionally depend on the scale of filtering window. Larger window has the good noise suppression capability, however image details (edges, corners, fine lines) preservation is proscribed, whereas a smaller window preserves the main points however it'll cause the reduction in noise suppression. Noise detection could be a very important a part of a filter, therefore it's necessary to discover whether or not the picture element is noisy or noise free. Solely noisy pixels are subject to de-noising and noise free pixels remains untouched.

2. Noise Model

There are two common kinds of the impulse noise square measure the Fixed-Valued Impulse Noise (FVIN), conjointly referred to as Salt and-Pepper Noise (SPN), and therefore the Random-Valued Impulse Noise (RVIN). They disagree within the potential values that vociferous pixels will take [6]. The FVIN is often shapely by-

$$(Y_{ij}) = \begin{Bmatrix} X_{i,j} \text{ with probabilty } p \\ (0,255) \text{ with probabilty } 1-p \end{Bmatrix} \text{.....(1)}$$

Where $X(i,j)$ and $Y(i,j)$ denote the intensity worth of the initial and corrupted pictures at coordinates (i,j) severally and p is that the noise density. This model implies that the pixels square measure haphazardly corrupted by 2 mounted extreme values, zero and 255 (for 8-bit grey-scale images), with an equivalent likelihood.

A model is taken into account as below:

$$(Y_{ij}) = \begin{Bmatrix} (0,m) & \text{with probabilty} & p1 \\ X_{i,j} & \text{with probabilty} & 1-p \\ (255-m,255) & \text{with probabilty} & p2 \end{Bmatrix} \text{.....(2)}$$

Where p = p1 + p2. We refer to this model as Random valued Impulse Noise (RVIN).

3. Different Methods

A mean filter act on a picture by smoothing it; that's, it reduces the intensity variation between adjacent pixels. The mean filter is nothing however an easy window special filter that replaces the middle worth within the window with the common of all the neighboring component values as well as it. By doing this, it replaces pixels that square measure atypical of their surroundings. It's enforced with a convolution mask, that provides a result that's a weighted add of the values of a component and its neighbors. It's conjointly known as a linear filter. The mask or kernel could be a square. Typically a 3× 3 kernel is employed. If the coefficients of the mask add up to 1, then the common brightness of the image do not seem to be modified. If the coefficients add to zero, the common brightness square measure lost, and it returns a dark image. The mean or average filter works on the shift-multiply-sum principle [12]. Within the special domain the foremost basic nonlinear filter is that the normal median filter (MF) [5]. Normal median filter replaces every component within the image by the norm of the corresponding filtering window. The quality median filter works effectively for low noise densities however at the price of blurring the image. contemplate that the component values in a very neighborhood square measure taken in to sequence money supply, M2, M3……..Mn. Adaptation median filter (AMF) Proposes a replacement adaptation 2nd special filter operator for the restoration of salt & pepper impulse corrupted digital pictures name as -"Salt & pepper impulse Detection and Median based mostly Regularization victimization adaptation Median Filter", The adaptation Impulse Filter effectively identifies the impulsive positions with a sound impulse noise detector associated replaces them by a reliable signal determined from an acceptable neighborhood. Experimental ends up in terms of objective metrics and visual analysis show that the projected rule performs higher than several of the outstanding median filtering techniques rumored in terms of retentive the fidelity of even extremely impulse corrupted pictures. Signal-dependent rank ordered mean filter is associate economical nonlinear rule to suppress impulse noise from extremely corrupted pictures whereas protective image details and options [8]. This methodology is applicable to any or all impulse noise models, as well as fastened valued (equal height or salt and pepper) impulses and random valued (unequal height) impulses, covering the entire dynamic vary. The filter effectively suppresses the noise, and preserves the small print and edges while not redundant increase in machine quality. Rank Conditioned Rank Selection Filter (RCRS) proposed the general structure of rank selection filters. The information utilized by RCRS filters is the ranks of selected input samples; hence the name rank conditioned rank selection filters. [12] The number of input sample rank utilized in this call is noted because of the order of RCRS filter. The order ranges from zero to the quantity of samples within the observation window, giving the filters valuable flexibility. Low-order filters will offer sensible performance and square measure comparatively easy to optimize and implement. Progressive switch Median Filter (PSM) could be a median-based progressive switch median filter, planned for the Removal of Impulse Noise from extremely Corrupted pictures.[9] The filtering technique is predicated on the subsequent 2 main themes: (1) switch theme : an impulse detection scheme is employed before filtering, so solely a fraction of all the pixels are subjected to filtering method and (2) Progressive strategies : each the impulse detection and therefore the noise filtering procedures square measure more and more applied through variety of iterations. the most advantage of this technique is that some impulse pixels placed within the middle of huge noise blotches may be properly detected and filtered, which ends in higher restoration, particularly for the cases wherever the pictures square measure extremely corrupted. Stargazer Equation primarily based on adaptative Median Filter [6], planned a replacement impulse detector that utilizes the variations between this element and its neighbors aligned with four foremost directions. once impulse detection, the filter merely don't replace rackety pixels known by outputs of median filter, however still build use of the knowledge of the four directions to weight the pixels within the window thus on preserve the small print of image. Advance Dual Threshold Median Filtering is used to De-noise the image by twin Threshold Median Filtering for Random Valued Impulse Noise. The planned technique provides higher PSNR values than different filters. The planned filter has evidenced that it's terribly economical for random valued impulse noise as a result of much noise isn't uniform over the channel. We have got used the idea of most and minimum threshold to discover each positive and negative noise. It produces superb PSNR and really little MSE for extremely corrupted pictures, particularly for over five hundredth noise density. This technique has the subsequent advantages: The average is a lot of correct than different filters. 2 thresholds used and therefore the threshold values will adaptively modification in line with the noise density .It will need separate calculation for average and threshold values, thus it reduces the delay and enhance the process speed of the filter with the assistance of data processing. Mounted Threshold twin Median filter during this technique twin median filtering is employed for rising PSNR and reducing MSE values. This technique is planned for the removal of random valued noise from the grayscale pictures. The rule consists of 2 stages. Within the 1st stage detection of rackety element is administrated and in second stage rackety element is replaced by average victimization twin median

filtering. The rackety pixels square measure detected with relevance 3 totally different conditions which end in effective detection. The experimental results show the planned theme performs higher than different previous schemes.

4. Results Compression

The result of our totally different strategies for removal of random valued impulse noise (RVIN) is shown during this section. For simulation and results of our projected algorithmic program we've to use MATLAB R2012b (8.0.0.783) software package. Here we've applied totally different algorithms on 2 terribly notable pictures within the digital image process field for result calculation that area unit - initial one is "Lena" and therefore the other is "Mandrill". The scale of each picture is 256X256. The testing pictures area unit unnaturally corrupted by random valued impulse noise (RVIN) by mistreatment MATLAB and pictures area unit corrupted by totally different noise density levels, variable from five hundredth to ninety the concerns. The performances of various algorithms are tested for various color pictures. Basic configuration of our system is Manufacturer: Hewlett-Packard HP 4540s Processor: Intel (R) Core (TM) i5-3110M computer hardware @2.40 GHz with 4.00 GB (2.64 GB usable) RAM: System type: sixty four-bit software. De-noising performances area unit quantitatively measured by PSNR and MSE outlined by:

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

$$MSE = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(Y_{i,j} - Y_{i,j})}{m \times n} \qquad (4)$$

Where MSE = Mean sq. Error M, N are range of channels, length and dimension of image severally. The values of Yi, j and Y' i, j are parts of original and filtered vector pixels severally.

The leads to the Table 1 show that the MSE values of various filters at high density of noise. Table I shows the comparison of MSE values of various filters for "LENA" image. Because the density of noise increasing, the response of the compared to the opposite filters like Median filter (MF) [4], Centre weighted median filter (CWM) [6] [15], Progressive change median filter (PSMF) [12], Signal dependent order median filter (SDROM) [9] [14], adaptive center weighted median filter (ACWM) [10] [11], (ACWMF), Tristate median filter (TSM) [13]. Here we have a tendency to see that our projected result's higher than alternative filters. This table shows the comparison between completely different noise density 50% to 90%.

The leads to the Table 2 show that the PSNR of projected technique higher at high density of noise. Table II shows the comparison of PSNR values of various filters for "LENA" image. This table shows the comparison between completely different noise densities 50% to 90%.

As the density of noise increasing, the response of the projected filter becomes higher as compare of alternative filters like Median filter (MF), Centre weighted median filter (CWMF), Progressive change median filter (PSMF) , Signal dependent order median filter (SDPOM), adaptive center weighted median filter (ACWMF) , Tristate median filter (TMF). Here Table 3 shows the comparative analysis of MSE of various filters for "MANDRILL" image and also the results.

Here we have got an inclination to simulate our fully other ways not alone in a passing high noise density, but an occasional noise density any. We have got an inclination to obviously see that no blur happens inside the upper de-noised pictures at eightieth and ninetieth noise density. As we've got an inclination to any or all acknowledge that if the PSNR worth is Here we tend to simulate our totally different strategies not solely in a very high noise density, however a low noise density furthermore. We tend to clearly see that no blur happens within the higher de-noised pictures at eightieth and ninetieth noise density. As we tend to all understand that if the PSNR worth is increase the results of an algorithmic rule is improved. PSNR improvement isn't solely a branch mark of image de-noised human and seeing conjointly is additionally important that's why once we quote the image talks not solely within the improvement of numbers however also specialize in the image sweetening.

TABLE 1
COMPARISON OF MSE VALUES OF DIFFERENT FILTERS FOR LEENA IMAGE

De-noising Methods	Noise density				
	50%	60%	70%	80%	90%
MF	2057.7	3919.5	6808.9	10071.1	14557.2
CWM	3258.9	5408.5	8376.8	11300	15243.3
PSM	650.25	1963.9	5048.5	9619	14914
IMF	264.9	493.1	1422.6	4009.4	10306
SDROM	2360.9	4396.2	7465.8	10791.4	14896.3
ACWM	2153.1	4009.4	6967.5	10071.1	14557.2
RACWM	540.8	1007.1	2056.2	4296.1	10071.1
TSM	3492	5930.3	9398.9	12678.8	16334

TABLE 2
COMPARISON OF PSNR VALUES OF DIFFERENT FILTERS FOR LENA IMAGE

De-noising Methods	Noise density				
	50%	60%	70%	80%	90%
MF	14.734	13.34	12.6	10.23	8.9
CWM	19.57	17.38	15.55	14.09	12.09
PSMF	19.4425	12.2215	9.9653	8.1236	6.6092
IMF	23.89	21.2	16.59	12.1	8
SDROM	22.15	19.86	16.77	14.59	12.7
ACWM	14.8	12.1	9.7	8.1	6.5
RACWM	20.79	18.1	15	11.8	8.1
TSM	19.44	18.55	16.47	14.77	13.39

The graphical illustration of PSNR for Lena image of various filters likes MF, CWM, PSM, IMF, SD-ROM, ACWM, RACWM and TSM is shown in figure 1. For low noise density all ways shows higher result however just in case of high noise density we've see the various changes within the PSNR values in numerous ways.

Where X-axis represents the various noise density between 50% to 90% and Y-axis represents the PSNR (dB) values of various filters. The PSNR of projected methodology doesn't decrease terribly quickly for prime density noise like alternative filtering ways, in fact, because the noise density will increase our filter holds far better PSNR then alternative noise removal filters. So in this part we have seen the different de-noising methods result with different calculation parameter. All these methods result compare with the two basic standard images. They are 'Lena' and 'Mandrill'.

5. Conclusion and Future Work

The proposed a comparative study of different methods results in terms of PSNR values and other filters. We have see the different filters has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel.

TABLE 3
COMPARISON OF MSE VALUES OF DIFFERENT FILTERS FOR MANDRILL IMAGE

Different Methods	Noise density				
	50%	60%	70%	80%	90%
MF	2203.3	3829	5285.4	9617.9	13585.6
CWM	3334.8	5285.4	7999.8	11042.8	14225.9
PSMF	729.6	1919	5165.1	8376.8	14557.2
IMF	264.9	493.1	1422.6	4009.4	10305.7
SDROM	2104.1	3918.1	6967.5	10071.1	14557.2
ACWM	2153.1	4009.4	6967.5	10071.1	14557.2
RACWM	620.9	984.1	1875.3	3741.8	8571.9
TSM	3573.3	5795.3	8975.9	12390.2	15598.4

In this paper we have focused on different de-noising methods and compare the result with different parameter in high noise density. There are many filters reviews available in low noise density but in case of high noise density not available.

In future we have designed a method that perform well result as compare shows methods in terms of PSNR, MSE and other quality parameters. We will focus on improving not only picture information as well as also enhance the edges of the picture. This is our major task in further research work.

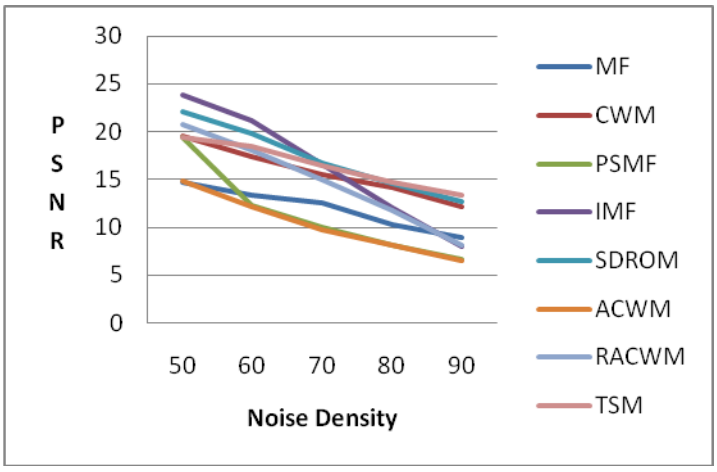

Figure 1: Graphical Representation of PSNR for Lena Image

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