Noise Smoothing- Improving Image Filtering Methodology

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Abstract:-

Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. For example if the image is under scanner from photography made on a film, noise can be he result of damage occured to the film during data acquisition.Noise occurance can also be there as image is acquired directly in digital form or noise data can also arise due to electronic transmission.Our goal in image restoration is to remove the noise from the image in such a way that original image should not be disturbed. We can use linear filtering method remove certain type of images, certain filters such as averaging or Gaussian filters were appropriate for noise filteing purpose.To remove salt and pepper noise from an image using an average filter , Double Derivative filter or a median filter are allowed for comparison.Here a new fuzzy logic method is applied for better efficient performance with less computational techniques as well as with less degradation.

Keywords:

Image Enhancement, Contrast, Fuzzy Logic, Fuzzy Statistics, Fuzzy Filter, Fzzy Logic Enhancment Technique(FLET), Mean, Variant,Standard deviation, Probability Density Function(PDF), Cumulative Density Function(CDF,Peak signal to noise Ratio(PSNR),

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 09
May 2016

Introduction: Noise suppression for image is still remaining as one of challenge among researchers.Impulse noise in image is predominant during acquisition, storage and transmission, it occurs in 2 type either fixed values (salt/pepper) or random valued. In salt pepper case the corrupted pixels assumes the maximum or minimum gray level, where as in random valued impulse noise the corrupted pixel will be any value within the dynamic range of maximum or minimum gray level.The main thrust in any filtering scheme is to remove the impulse noise while preserving the imge details in restored image.The existing impulse noise removal schemes are classified in 2 categories namely filtering without detection and detection prior to filtering.The non linear standard median filter falls under ist category. It is computationally efficient simple to impliment but it performs poorly in high density impulse noise.Further the filtering under ist category performs filtering operation on all pixels of an image irrespective of its corruption status and as a result he restored image suffers from loss of edge and other image details.The second category of filter detects a pixel under consideration to be corrupted or not.Subsequently it applies a filtering operation on the corrupted pixels only keeping the non corrupted one intact.This selection filtering shows perior performance in restored images.Pregressive switching median filter(PSMF),Adaptive median filter(AMF),minimum maximum exclusive mean are few and methods which perform well in low as well as high density impulse noise.The progressive switching median filter achieves the detection and removal of impulse noise in 2 separate stages.In Ist stage it applies impulse detection and the noise filter is applied progressively in iterative manner in 2nd stage.In this method impulse pixels located in the middile of large noise blotches can also be properly detected and filtered.The performance of this method is not good for high density noise.Adaptive median filter is used for dicriminating corrupted and uncorrupted pixels are left unchanged it performs well at low noise intensities but at higher noise densities window are to be increased to get better noise removal which which lead to less correlation between corrupted pixels and replaced median pixel values.The noise mximum exclusive mean filter use meanvalue instead of median value of neighboring pixels to remove impulse nise from highly corrupted pixels.Simulation results show that even if the occurence rate

International Journal of Research
Available at https://edupediapublications.org/journals
p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 09
May 2016

of impulse noise is very high 70%, the restoration performance is still corrupted.A noise adaptive soft switching median filter is suggesed, so an efficient decision based algorithim (EDBA) and subsequently its impulsive decision based algorithim have been proposed to combat the high density impulsive noise.The FLET(decision based alg) uses a fixed window size 3×3 where the corrupted pixels are replaced by either the median pixel or neighbourhood pixels, it shows promising result with lower processing time which degrades viual quality of the image as the noise density increased.The modified decision based unsymmetric trimmed median filter replaces the noisy pixel by trimmed median values other pixel values,0's and 255's are present in the selected window and when all the pixel values are 0's and 255's, then the noise pixel is replaced by the mean value all the elements present in selected window.

The paper is organized as follows, the impulsive noise model is given in section II,sectionIII deals with proposed scheme.In section IV the simulation results along with comparative analysis are dicussed in detail.Finally section V gives the concluding remarks.

Fuzzy Logic Enhancement Filter:

The FM filter erorm impule denoising by raster scanning the noisy image with 3×3 search window s shown in figure 1. Each element in the search window is treated as a fuzzy input variable that is defined by $w_x = w_x - w_c$: x=1,2,3,.........8 (1)

w1	w2	w3
w4	w5	w6
w7	w8	w9

Figure 1: the 3×3 search window.

II:

Impulsive noise can be classified on salt and pepper noise and random valued impulsive noise.An image contains impulse noise can be described as

$$x(i,j) = \begin{cases} \eta(i,j) & \text{with probability } p. \\ Y(i,j) & \text{with probability } 1-p. \end{cases}$$

fig(a) represents if salt pepper noise Ri,j Є (n_{min}, n_{max}).

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 09
May 2016

0s {0,255}
255

0 (0,255)
255

fig(b) represents random valued noise Ri,j Є (n_{min},n_{max}).

x(i,j) = noisy image pixel
y(i,j)= denotes a noise free image pixel.

η(i,j) a noisy impulse at the location(i,j) and η(i,j)Є(lmin,lmax) where lmin,lmax denotes the lowest and highest pixel intesity values within the dynamic range respectively.

III.- Proposed scheme:

it works in 2 stages means noise detection is followed by an application of FLET to the corrupted pixels only.If the centre pixel in 3×3 window is either o or 255 is considered to be noisy.If the total no of non noisy pixels is greater than equal to 3 then the test pixel is replaced with median of healthy neighbourhood pixels.

Otherwise size of window is increased to 5×5 and the process is repeated till the window size reaches a predefined maximum window size.The FLET alg steps are given below.

FLET Algorithm:
Input- The noise image Y
output The filtered image 'X'.

step 1: Initialize a sub window under w=3. And maximum window size wmax =15
step2 :Select a sub window of size w×w with centre pixel as x_{ij}.
step3: If xij (0,255) shift the window and go to step 1.(noise free pixel).
Step 4: Collect the set of pixels from the sub window ignores the pixel with 0 or 255.
step 5: if size s>=3
(i) Replace x_{ij} with median of pixels in S.
(ii) Shift the window.
(iii) Go to step 1.
Step 6: w=w+2
Step 7: w<= w_{max} go to step2
else replace the centre pixel by mean of the pixels in subwindow of size wmax.
Step 8: Repeat step 2 to step 7 for all pixels in the image.

IV. **Simulation Results and Discussion:**

To validate the efficacy of the proposed FLET scheme simulation has been carried out in standard image like Lena and clown (120×120) and (320×320) pixels in MATLAB.The image is subjected to as low as 10% to as high as 90% noise densities.The proposed scheme along with performing schemes like SMF,AMF,PSMF etc are applied to the noisy images.The window size is made variable for SMF at variou noise densities.Subjective as well as objective evaluation have been made for each is restored images.The quantitative measures used are defined below.

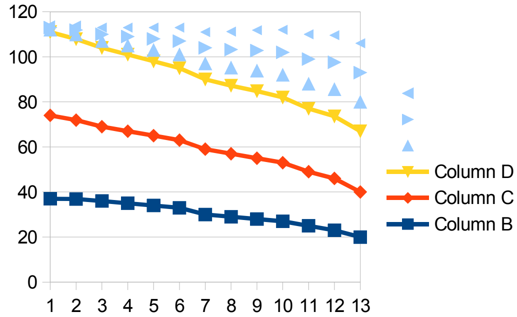
A.Peak signal to Noise Ratio(PSNR)

$PSNR_{db} = 10 \log_{10}(255^2/MSE)$

where mean square error(MSE) for an M×N is defined as

$$MSE=\frac{1}{MN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}(X_{i,j}-X'_{i,j})^2$$

where image x_{ij},,Y_{ij} and x'_{ij},, are the original degraded and the restored images respectively.



X'_{ij} is the output of the fuzzy filter and w(x,y) is the weighted function.The neighborhood is denoted by i and j.With different weighting functions we can develop more improved Fuzzy filters.

Output fuzzy filter=O(x,y)= $x_{11}+x_{22}+x_{33}/3.5$.where as pixels of tested window w_x is passed through mathematical manipulators and then membership functions as follows .

$\nabla 1 = ((x_{11} + x_{33})/2) - x_{2,2}; \nabla 2 = (x_{3,1} + x_{1,3})/2 - x_{2,2};$

Then these membership funtions are **μ_1 (x)=**

0 x< a

x-a/b-a otherwise.

μ_2 **(x) =**

0 x>-a

x+a/a-b -b<x<-a

1 x<-b.

Where a and b values are assumed as .25 and .35 which can be changed according to noise value percentage.

Enhanced Image Model

Conclusion:

The proposed method has been tested on different standard test images.It shows the

p-ISSN: 2348-6848
e-ISSN: 2348-795X
Volume 03 Issue 09
May 2016

maximum window size reached and the computationally techniques are calculated.Effective use of this method requires a proper value wmax which maximizes the probabilities that the only tested pixels will take part infiltering operations and reduces the computational times.To choose an optimal value for wmax which can be used properly,in this paper we have used w_{max} =15or all the tested images.The filter described efectively works on both gray and color images.To show the effectiveness of the filters results are shown.Simulation results are shown for Lena images.Mean square error is taken as a performance measure to show the effectiveness of proposed filters.

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