

Development of Adaptive Mean Filters for Images Corrupted with Fixed Value Impulse Noise

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ABSTRACT:Image restoration refers to removal or minimization of degradations in an image. This includes de-blurring of images degraded by the limitations of a sensor or its environment, noise filtering, and correction of geometric distortion or non-linearity due to sensors. Image is restored to its original quality by inverting the physical degradation phenomenon such as defocus, linear motion, atmospheric degradation and additive noise.

Preprocessing techniques has vital role in the image processing. In preprocessing techniques, the corrupted image has been restored by using linear/nonlinear filter for suppressing/removing the noise without information loss. Nonlinear adaptive mean based filters denoise the salt-pepper noise with higher degree of edge preservation. In this paper three algorithms are proposed to denoise the salt and pepper noise.

This is aimed to analyze the performance of linear and non-linear filters namely Adaptive SelectiveMax Round order Mean Filter (ASMROMF), Adaptive Selective Min Round Order Mean Filter (ASMROMF), and Adaptive Selective Bi-Stage Round Order Mean Filter(ASBSROMF). For this purpose, standard image taken and it is corrupted with the most popular fixed impulse noise. Salt and pepper noise, by varying the noise probability from 10% to 90%. Then denoising is done using above mentioned filters. The performance of these filters are measured using the quality metric namely PSNR and are tabulated. The proposed filter performs, such better when compared to other filters. For better visual interpretation the results are shown as graphs.

KEYWORDS:Adaptive SelectiveMax Round order Mean Filter , Adaptive Selective Min Round Order Mean Filter , and Adaptive Selective Bi-Stage Round Order Mean Filter, Salt and Pepper Noise, Mean Filter.

I. INTRODUCTION

Image Restoration is the process of eliminating or reducing noise from a degraded image with an objective to recover, the original image. Noise is degradation factor that is measured in terms of unwanted/unrelated information present in the image. Noise may originate from many sources like faulty sensors in capturing device, inconsistent atmospheric conditions and error prone transmission media. Based on the distribution, noise Based on the distribution, noise into many types such as represented in some mathematical and /or statistical models. Such noises are Impulsive Noise, Poisson Noise, Exponential Noise, Thermal Noise, etc. Among these, impulsive noise frequently corrupts the images due to the limitations and defects in acquisition and transmission media/process. The impulsive is distributed over the image in terms of non correlated neighboring pixels.Noise is an undesirable signal which is a degradation factor that is measured in terms of unwanted information present in the image. The sources of noise are faulty sensors in capturing device, inconsistent atmospheric conditions and error prone transmission media. Types of noise are impulsive noise, Poisson noise, exponential noise and thermal noise etc.

The noise filtering techniques are divided into linear and non-Linear filtering. Mean filtering is a simple, intuitive and easy to implement method of *smoothing* images, *i.e.* reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images.

II. SALTAND PEPPER NOISE

Salt and pepper noise is an impulse type of noise, which is also referred to as intensity spikes. This is caused generally due to dead pixels, analog-to-digital converter errors, errors in data transmission, malfunctioning of pixel elements in the camera sensors, faulty memory locations, or timing errors in the digitization process. It has only two possible values, 'a' and 'b'. The probability of each is typically less than 1. The corrupted pixels are set alternatively to the minimum or to the maximum intensity values, giving the image a "salt and pepper" like appearance. Unaffected pixels remain unchanged. For an 8-bit image, the typical intensity value for pepper noise is 0 and for salt noise 255.

III. MEAN FILTER

It is the simplest mean filter. Let S_{xy} represents the set of coordinates in the sub image of size $m \times n$ centered at point (x, y) . The arithmetic mean filter computes the average value of the corrupted image $g(x, y)$ in the area defined by S_{xy} . The value of the restored image f at any point (x, y) is the arithmetic mean computed using the pixels in the region defined by S_{xy} . This operation can be using a convolution mask in which all coefficients have value $1/mn$. A mean filter smoothes local variations in image Noise is reduced as a result of blurring. For every pixel in the image, the pixel value is replaced by the mean value of its neighboring pixels with a weight. This will result in a smoothing effect in the image.

$$\hat{f}(x, y) = \frac{1}{mn} \sum_{(s, t) \in S_{xy}} g(s, t)$$

The mean filter is a simple sliding-window spatial filter that replaces the center value in the window with the average (mean) of all the pixel values in the window. The window, or kernel, is usually square but can be any shape. An example of mean filtering of a single 3×3 window of values is shown below.

unfiltered values		
5	3	6
2	1	9
8	4	7

$$5 + 3 + 6 + 2 + 1 + 9 + 8 + 4 + 7 = 45$$

$$45 / 9 = 5$$

.mean filtered		
*	*	*
*	5	*
*	*	*

Center value (previously 1) is replaced by the mean of all nine values (5).

3.1 ADAPTIVE SELECTIVE MAX ROUND ORDER MEAN FILTER

The maximum filter enhances bright values in the image by increasing its area. That brightness pixel then becomes the new pixel value at the center of window. This filter is useful for finding the brightest points in an image. The maximum filter is defined as the maximum of all pixels within a local region of an image. The maximum filter is typically applied to an image to remove negative outlier noise.

ASMRMF among that alone median values area unit used for the replacement of the corrupted pixels. The new formula at first detects the impulse noise among the image. The arithmetic mean filter computes the average value of the corrupted image. It checks the central pixels of window if check the central pixel is corrupted and uncorrupted part among the image area unit detected by checking the picture value if it's corrupted then read the diagonal pixel of central pixel in window and find the mean(D_m) and read the adjacent pixel of central pixel in window and find the mean(A_m) then compute the maximum of mean and replace the central pixels. The decision based mostly filter is featured to revive impulse corrupted digital photos even in very corrupted environments.

3.1.1 ALGORITHM

- (i) Read the Diagonal pixels of C_p in W and find the mean(D_m)
- (ii) Read the Adjacent pixels of C_p in W and find the mean(A_m)
- (iii) Compute the maximum of $\text{meanM} \leftarrow \max(D_m, A_m)$

3.1.2 ADAPTIVE SELECTIVE MIN ROUND ORDER MEAN FILTER

The Minimum filter enhances dark values in the image by increasing its area. That darkest pixel then becomes the new pixel value at the center of the window. This filter is useful for finding the darkest points in an image. Also, it reduces salt noise as a result of the min operation.

ASMRMF among that alone mean values area unit used for the replacement of the corrupted pixels. The new formula at first detects the impulse noise among the image. The arithmetic mean filter computes the average value of the corrupted image. It checks the central pixels of window if check the central pixel is corrupted and uncorrupted part among the image area unit detected by checking the picture value if it's corrupted then read the diagonal pixel of central pixel in window and find the mean(D_m) and read the adjacent pixel of central pixel in window and find the mean(A_m) then compute the minimum of mean and replace the central pixels. The decision based mostly filter is featured to revive impulse corrupted digital photos even in very corrupted environments.

3.1.2 ALGORITHM

- (i) Read the Diagonal pixels of C_p in W and find the median(D_m)
- (ii) Read the Adjacent pixels of C_p in W and find the median(A_m)
- (iii) Compute the minimum of $\text{meanM} \leftarrow \min(D_m, A_m)$

3.1.3 ADAPTIVE SELECTIVE BI-STAGE ROUND ORDER MEAN FILTER

Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. It is often used to reduce noise in images. ASBSROMF among that alone mean values area unit used for the replacement of the corrupted pixels. The new formula at first detects the impulse noise among the image. The arithmetic mean filter computes the average value of the corrupted image. It checks the central pixels of window if check the central pixel is corrupted and uncorrupted part among the image area unit detected by checking the picture value if it's corrupted then read the diagonal pixel of central pixel in window and find the mean(D_m) and read the adjacent pixel of central pixel in window and find the mean(A_m) then compute the average of mean and replace the central pixels. The decision based mostly filter is featured to revive impulse corrupted digital photos even in very corrupted environments.

3.1.3 ALGORITHM

- (i) Read the Diagonal pixels of C_p in W and find the mean(D_m)
- (ii) Read the Adjacent pixels of C_p in W and find the mean(A_m)
- (iii) Compute the average of $\text{meanM} \leftarrow \text{round}(D_m, A_m)$

IV.EXPERIMENTAL RESULTS

Table 1 shows the PSNR values obtained for image1 for 3×3 window by Adaptive Selective Max Round Order Mean Filter , Adaptive Selective Min Round Order Mean Filter,Adaptive Selective Bi-Stage Mean filter for different noise probability varying from 10% to 90%.

Table I:The PSNR values obtained for 3 ×3 window standard lena image

Filter type	Noise Level (%)								
	10	20	30	40	50	60	70	80	90
ASMROMF	31.75	28.4	25.69	24.14	22.44	21.22	19.61	18.17	16.37
ASMROMF	31.65	27.87	25.74	23.76	22.04	20.1	19.5	17.78	15.13
ASBSROMF	31.54	27.59	25.23	23.45	21.37	20.64	19.81	18.78	15.85



a) Original Image



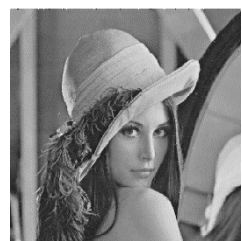
e)Filtered by ASMROMF of (d)



b)10% corrupted image by ASMROMF



f) 10% corrupted image by ASBSROMF



c) Filtered9 by ASMROMF of (b)



g)Filtered by ASBSROMF of (f)



d)10% corrupted image by ASMROMF

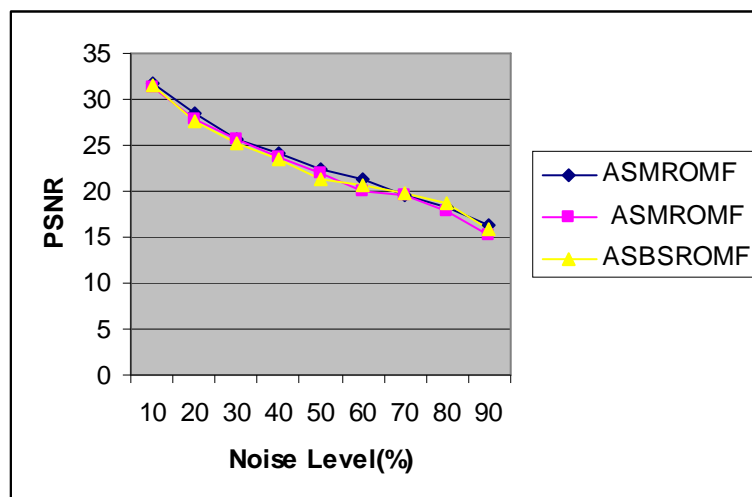


Figure1 Comparison of Adaptive Mean Filters for standard lena image for a window size of 3×3

V. CONCLUSION

This paper presented an experimental analysis of mean based impulse noise removal for gray scale images. Our experimental results show that, among the methods compared, Adaptive Selective Max Round Order Mean filter, Adaptive Selective Min Round Order Mean filter and Adaptive Selective Bi-Stage Round Order Mean filter exhibit visually appealing results. For the Standard image, the performance of Adaptive Selective Max Round Order Mean Filter is found to be maximum up to 10% to 90% of noise for a 3×3 window size. Where as the Adaptive Selective Min Round Order Mean Filter, Adaptive Selective Bi-Stage Round Order Mean Filter is found to be minimum for noise density from 10%-90%. The Results show that the Adaptive Selective Max Round Order Mean Filter using iterative and non-iterative methods give good results with respect to PSNR Values as well as the human Visual System. This analysis may help us to choose the denoising filter appropriately for a standard image for a given noise probability.

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