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EVALUATION OF DIFFERENT MEDIAN FILTERS FOR IMAGE PROCESSING TASKS

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ABSTRACT

Impulsive noise is captured at the acquisition stage of digital image processing. It is an important step in the pre-processing process which is used to improve the image quality and make it moreinformative. There have been several proposed image-denoising algorithms, each with advantages and disadvantages. This work gives a thorough investigation of the median filter and its various variations forthe reduction or elimination of impulsive noise in grey scale images. In terms of usefulness and comparative performance, Standard Median Filter, Adaptive Median Filter and Modified Median Filter are contrasted. On a set of pictures, thorough MATLAB-based simulations have been run to assess the performance of the current algorithms. Peak Signal to Noise Ratio was employed to compare performance in this case (PSNR). In terms of relative statistical performance, the Modified Median Filter (MMF) is the best.

Keywords: adaptive median filter, PSNR, standard median filter, MATLAB, median filter.

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1. INTRODUCTION

Images are significant and required for communication. Every day, a large number of photographs are created, translated, and modified. The quality of photographs is inconsistent due to the range of imaging technologies. As you go between different devices, some data could get corrupted. Noise is the most troublesome issue with image processing. It causes the image to randomly change, changing the original values to several other values.The creation of a resilient algorithm that can process the image even in the presence of noise is one approach to solving this issue. The mean of an average percentage gradient difference serves as the basis for the AMF method. Noise filtering, rough noise detection, and tiny noise sensing make up the entire filtering process. At all levels of salt-and-pepper noise, a NAMF can provide a considerably higher level of restoration quality than innovative techniques [14]. The NAFSM filter was first developed to distinguish between pixels with noise and those without noise. The noisy pixels were then subjected to preliminary filtering. Second, an adaptive norm with scale parameters derived using local characteristics was devised to measure the intensity difference between picture patches [10].

The filter's primary responsibility is to scan all input data using the "window" method's median function, in between each individual entry and the total number of entries. Over the higher-dimensional signals, the window inevitably becomes more complex. A different approach, which has been tried and proven, will choose a window to deal with noisy pixels based upon this MF, choosing the window with the right size using picture padding. [15]. For the restoration of badly distorted coloured images brought on by salt and pepper noise and arbitrary impulse noise, an MCF Whereas another number of pixels, such as 0s and 255s, are present in the chosen window, the MCF technique restores the noisy pixel with just a median value. [8]. They have given a thorough study that focuses on treating the unaffected and infected pixels so that this approach leads to improving the performance of the filter by increasing the values of the filter's quality parameters in order to get rid of some of the drawbacks of the median filter. [1]. for the elimination of odd impulse noise, an excellent noise reduction algorithm, and its VLSI design [2]. To enhance the SMF's ability to remove noise from the surface picture, a Pixel (PDBTMF) method is suggested. [7]. The DBMF is used at the input side to remove noise effectively. In comparison to the other methods given for finding the weights of the RWM filter, the median controlled approach is less complicated [6].

When comparing processed photographs to the original and other options, quality measures are used to judge how much the quality of the images has improved. Measurement of image quality is crucial for many applications of image processing. Compression is one application where it's important to monitor how well images are decoded or compressed.

2. MEDIAN FILTER

A nonlinear approach for removing noise from pictures is MF. It is frequently used because it successfully eliminates noise while maintaining edges. It works wonders at eliminating "salt and pepper" noise. The MF runs pixel-by-pixel well over the image, replacing each pixel well with the median of the pixel nearby. The "window" is a neighbourhood pattern that moves pixel after pixel across the input frame. The median is derived by changing the image under evaluation for the middle gray levels after numerically ranking every one of the image pixels from the window.

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2.1 Standard Median Filter

The typical median filter serves as the fundamental median filter. The center pixel filtered pixel using this method of window size 2k+1, in which k values from 1 to N. After sorting the pixel window, the pixel center is altered to reflect the median value of the sorted series. Because it is the most straightforward median filtering approach, it has been in use for a very long time.

a) Impulse noise detection

This process generates two image sequences: one that shows the image's pixel values after N iterations and the other that shows whether a pixel is corrupted or not. The second set of images is known as the flag sequence. All of the flag sequence's pixel values are first given the value 0, which denotes that they are all intact. The flag sequence is adjusted to 1 if the pixel is identified as noise after the detection method has been applied, and it remains unchanged if the pixel is noise-free.

b) Filtering phase

The first phase's faulty pixels are filtered in this stage. The image is filtered using two image sequences: the flag sequence from the first phase and the corrupted pixel sequence.

2.2 Adaptive Median Filter

The noise identification and filtering procedures are also applied by the adaptive median filter to eliminate noise. By nature, the filtering window's size is adaptive; if the necessary condition is not true, the window size is increased. If the condition is true, the pixel is filtered by using the frame's median. Let W be the size of the window, Wmax be the max size of the window and med I is the median assigned value. Assume ij I as image's pixel that is corrupted, min I is min value of that pixel and max I as its max value of pixel. The Filter is performed following two steps:

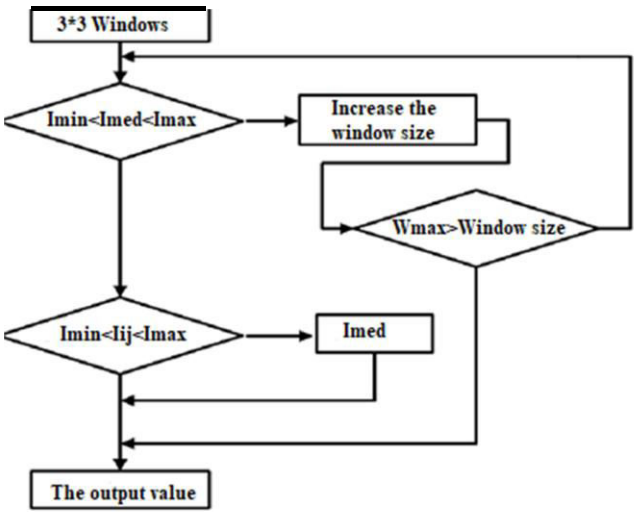
Level A

If min I < med I < max I, If the algorithm determines that the median value is not an impulse, it proceeds to Level B to determine whether the current pixel is an impulse. b) the window size is enlarged and Level A is repeated until the algorithm reaches Level B since the median value is not an impulse; alternatively, the maximum window size is achieved, in which case the median value is designated as the pixel value for the filtered image.

Level B

If min I < ij I < max I, then consequently the filtered image pixel remains unaffected because the current pixel value is not an impulse.. b) If the image pixel is not equal to max I or min I (corrupted), the pixel is filtered and the Level a median value is assigned. These median filters are frequently used to remove noise from images after denoising when the noise density is above 20%.

Flowchart



2.3 Modified Median Filter

The modified based median filtering method first determines whether the pixel value is corrupted before processing the corrupted picture pixels. This decision depends upon whether the number of pixels to be processed lies between the maximal and minimum values within the processing window, much like the AMF technique. A noise-free pixel is retained if its value falls between the window's minimum and maximum values; otherwise, it is replaced with either the window's median value or a pixel value in its immediate vicinity. The following is a description of the modified based median filtering technique's whole algorithm:

Step A

The first step is to choose a window and determine its minimum, maximum, and median values. Let ij I represent the pixel value, and max I, min I, and med I stand for the maximum, minimum, and median pixel values in the window, respectively.

Step B

If min I < ij I < max I, if not, the pixel value is not impulse noise, and it is kept in the filtered image. Otherwise, it is impulse noise.. b) If ij I be an impulse noise, it is then determined whether or not the median value is also an impulse noise. If min I < med I < max I or 0 255 med < < I, the median is not an impulse noise, and the filtered image pixel is replaced by the median value of the window. c) If the median also contains impulsive noise, the value of theleft neighbourhood pixel value will be used in place of the filtered image pixel.

Step C

Until every pixel has been tested, these actions are repeated.

There are some noisy photos when sending pictures over channels because of unidentified communication. SPN (Salt & Pepper Noise) is also known as impulsive noise where filtering goal is to eliminate that

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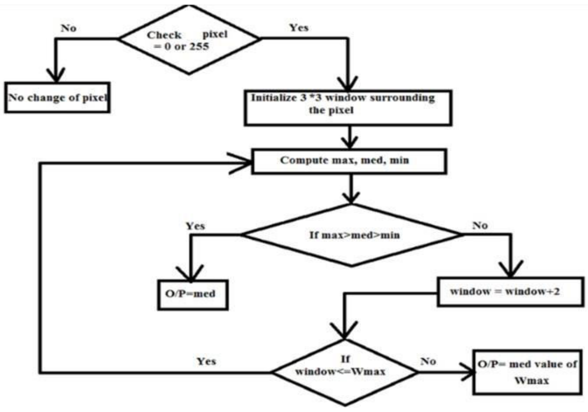
SPN, the noisy free images are entirely recovered with minimal signal distortion. The finest digital filters for removing impulsive noise are nonlinear ones. Adaptive the median filter recognizes the noisy pixels and arranges them as the original, noise-free pixels. Although the method takes longer to run, it can nevertheless detect images with a higher density. For removing SPN from images without altering edges that have already been saved, median filter techniques are well characterised. Existing nonlinear filters like the SMF and AMF perform better at low and medium noise concentrations than they do at high noise densities. We can eliminate SPN with a modified sheer sorting.

Flowchart



3. ESTIMATION OF QUALITY METRICS

3.1 PSNR Noise

Peak signal-to-noise ratio (PSNR) is an acronym for the relationship between the maximum allowed value of a signal and the strength of disrupted noise that reduces the signal's ability to be accurately represented. As most signals have a really large dynamic range, the PSNR is often expressed as follows in the linear interval scale.

Enhancing a digitized image's visual quality by appropriate changes can be arbitrary. Whether or not one strategy produces visuals of a greater caliber varies depending on the individual. It is crucial to establish measurement methods to compare how image enhancing techniques affect image quality.

To determine which method produces better results, different image improvement methods can be systematically tested on the same set of test photos. The statistic under investigation is the peak signal-to-noise ratio. If we can show how an algorithm can restore a proven image quality to resemble the original, we can conclude that it is superior.

3.2 Expression of PSNR Noise

For the purposes of the following method, presume that we are working with a standard 2D data array or matrix. The dimensions of the reduced image matrix must be identical to those of the original picture matrix. The PSNR is mathematically represented as follows:

PSNR = 20*log (max (max (a)))/ ((MSE) ^0.5)
MSE = (1/ (b*c))*sum (sum ((a-e). ^2))

Where,

a) is a representation of our original matrix data of the image.

b) stands for the matrix data of the degraded image in question.

c) is the no of rows in pixels**.**

d) stand for the no of pixel columns in the image

4. RESULT AND DICUSSIONS

The sample images Lena and Baby, which are displayed in Figures 1 and 2, each have a 256 by 256 pixel size, and all of the aforementioned methods have been applied to them. The images are given impulse noises, and their performances are assessed. The MSE and PSNRof the images are computed after applying noisy values from 10% to 50% to the images. Calculating the PSNR involves basic equations. It should be noted that the filtration improvesas the PSNR value increases. These results are shown in tabular form in Table-1.

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Table-1. Comparison of PSNR noise of various filters.

IMAGE	FILTER	10	20	30	40	50
Cameraman	SMF	24.79	22.02	20.30	19.13	18.13
	AMF	24.92	22.16	20.25	19.00	18.07
	MMF	34.65	31.51	29.35	27.76	26.14
Baboon	SMF	19.58	19.32	18.98	18.65	18.26
	AMF	25.76	23.45	20.16	16.81	13.75
	MMF	28.02	25.96	24.24	22.84	21.59
Lena	SMF	25.00	23.39	22.32	21.15	20.49
	AMF	33.45	28.29	22.53	18.26	14.79
	MMF	37.54	33.34	30.96	28.24	27.02
Kids	SMF	13.87	10.83	10.30	7.82	6.83
	AMF	24.76	17.56	12.54	11.23	10.94
	MMF	31.70	29.97	28.52	27.24	26.24
Street	SMF	26.12	24.94	23.64	22.73	21.88
	AMF	35.74	29.04	29.04	18.02	14.43
	MMF	38.26	34.61	34.61	30.20	28.33
Pepper	SMF	23.86	22.94	21.08	22.73	21.88
	AMF	31.92	26.11	21.58	18.02	14.43
	MMF	35.49	31.38	29.51	27.22	28.33

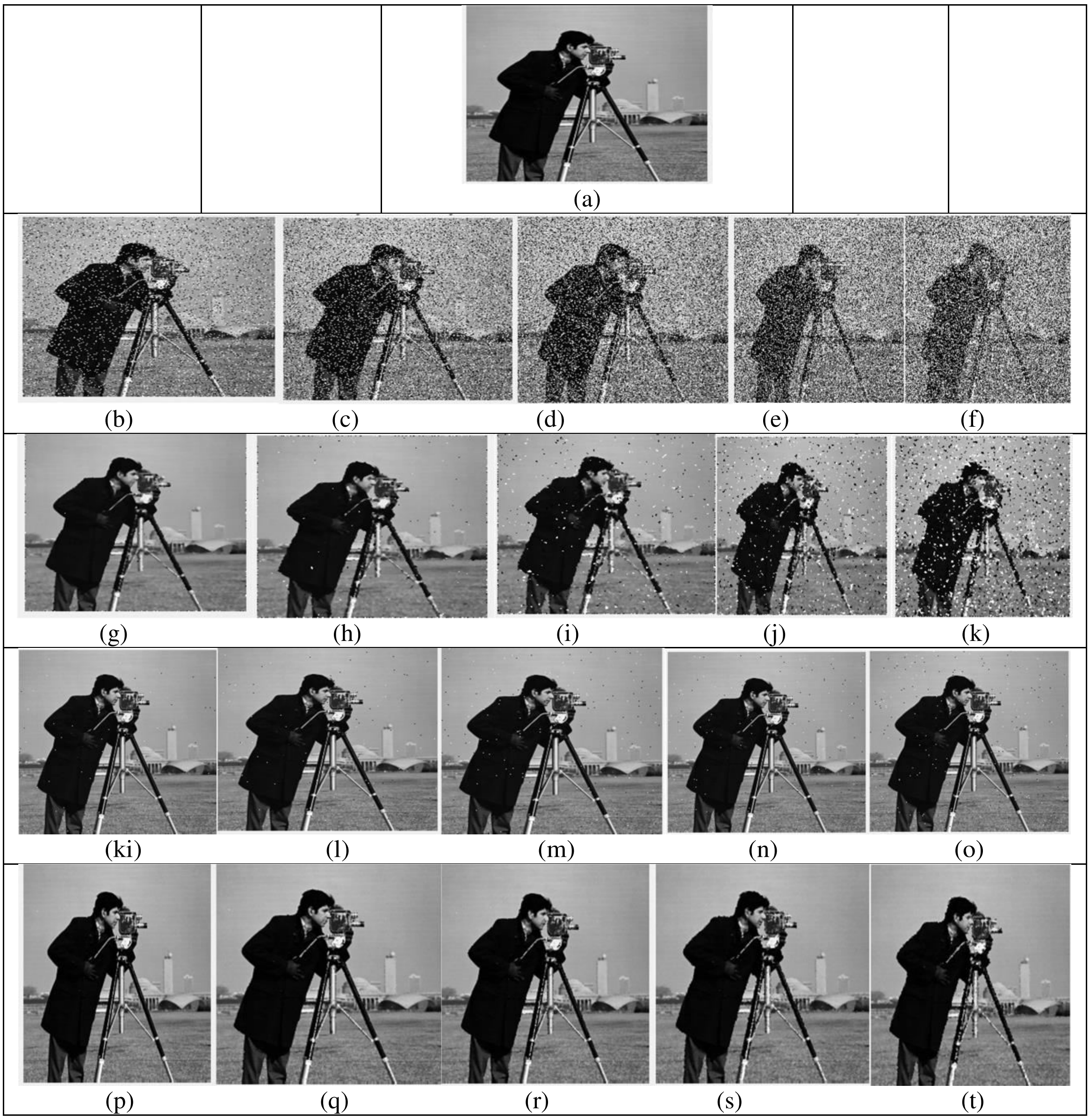

Figure-1. Removal of Salt And Pepper Noise of Sample A (a) Original image (b) Corrupted Image With 10% Noise (c)20% Noise (d)30% Noise (e)40% Noise (f)50% Noise (g- k)Restored of Image using SMF for Different noise respectively (ki-o) Restored of Image using AMF for Different noise respectively (p-t) Restored of Image using MMF for Different noise respectively.

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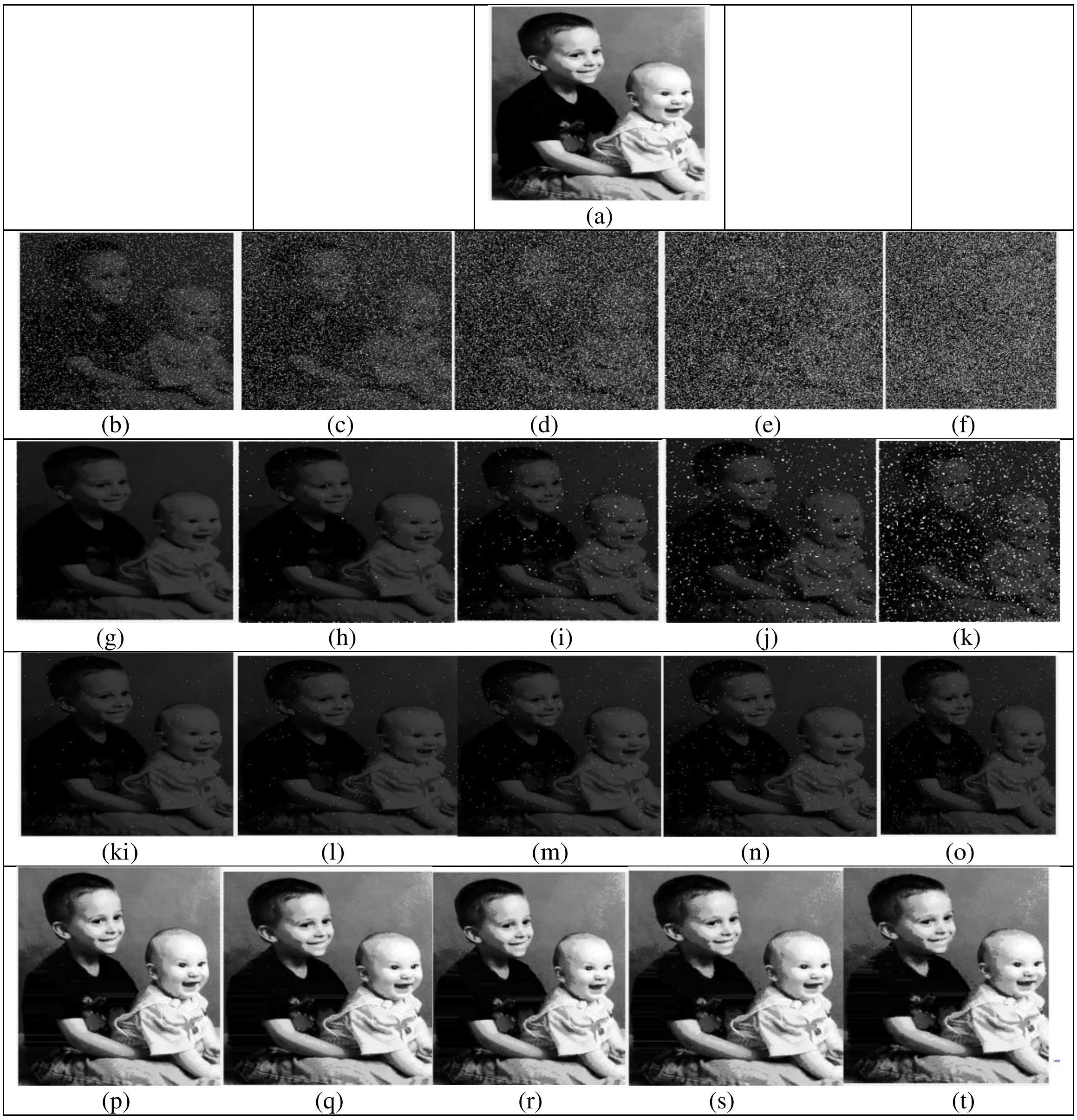

Figure-2. Removal of Salt And Pepper Noise of Sample B (a) Original image (b) Corrupted Image With 10% Noise (c) 20% Noise (d)30% Noise (e)40% Noise (f)50% Noise (g- k)Restored of Image using SMF for Different noise respectively (ki-o) Restored of Image using AMF for Different noise respectively (p-t) Restored of Image using MMF for Different noise respectively.

5. CONCLUSIONS

In this paper, by using a non-linear filter called a median filter and calculating the PSNR noise, the impulse noise, sometimes referred to as salt and pepper noise, is minimised. Hence in order to find the effective Median algorithm for minimizing the salt and pepper in corrupted images different algorithms such as SMF, AMF, and MMF were implemented. In addition, a comparison was made to measure PSNR noise among the implemented algorithms in order to find an effective algorithm to enhance the image. Among these algorithms, the modified median filter has the highest PSNR noise ratio i.e. 34.65 for the cameraman for 10% noise whereas 24.79 for SMF and 24.92 for AMF likewise different images are compared with different levels of noise for various median algorithms. Hence modified median filter provides better results than the existing median algorithm because it results in the highest PSNR noise ratio.

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