A Review: Various Image Denoising Techniques

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ABSTRACT
Removal of noise is an essential and challengeable operation in image processing. Before performing any process, images must be first restored. Images may be corrupted by noise during image transmission through electronic media. Noise effect always corrupts any recorded image which is much more harmful for future process. To overcome the problem of noise level in digital images this paper present a review of different image denoising method. In this paper various filters are used for image denoising. This proposed method adopt first and second order mean filter (FSOMF) in which for first phase we detect the impulse noise. And the second phase which is also called as filtering phase replaces the detected noise pixel. Finally able to show in our experimental result of proposed method FSOMF, is capable of filtering of impulse noise.

Keywords
Denoising, Mean Filter, Impulse Noise.

1. INTRODUCTION
Digital images plays very important role in our day to day life applications such as medical imaging, computer vision, satellite television, computer tomography as well as in areas of research and technology such as geographical information systems etc. In image processing, impulse noise reduction is an active area of research. With the usage of multimedia material becoming more prevalent from day to day, visual data from high value digital images performances a significant role. Some with low computational complexity, a good noise filter is required to satisfy two criteria namely, to reducing the noise and suppressing the useful information in the signal. Image denoising the corrupted likeness is performed by using the preprocessing process. Preprocessing is very important because subsequent procedures (e.g., likeness segmentation, enhancement, classification, parameter estimation, etc) are mostly influenced by the value of the filtered image.

The main purpose of image denoising is to reform corrupted pixels estimate as in the original image from the noisy image. Image denoising and preprocessing are the important task and in digital image processing image denoising is an important area. For impulse noise reductions there are many filters available although these methods have been improved time to time, but the quality of denoised image is still not provide satisfactory results. From past few decades a number of methods have been suggested for the removal of impulse noise, nonlinear filters can be considered as the state-of-the-art methods granted their impressive performances. For example, the mean filter is one of the choice for stifling impulse noise. It is directed in order to use some filter for identically finds all the noise and noise fee pixels. But due to these methods some fine details and image borders are blurred, the mean filter often leaves attractive minutia at best blur and at worst missing. Many difficulties has been faced to the development of various categories of filters such as the mean-based filters, adaptive filters, the performances of these filters does not produce better results.

In this paper, focus on providing a robust filter that detect and correct the noisy pixels i.e. for any type of impulse noise models. propose first and second order mean filter (FSOMF), for detail preserving and restoration of information. The FSOMF filter operates at a wide range of impulse noise densities without falling in a situation in which there is a danger of loss, harm, or failure of image fine details colors and textures. The proposed filter does not require any type of training algorithm and time consuming training of parameters as well.

2. LITERATURE SURVEY
In 1989 A.K. Jain [1] introduced a "Fundamentals of Digital Image Processing". In this paper first he used median filter which is one of the most popular nonlinear filters. It is very simple to implement and much efficient as well. The median filter, especially with a larger window size destroys the fine image details due to its rank ordering process. It acts like a low pass filter which blocks all high frequency components of the image like edges and noise, thus blurs the image. As the noise density increases, the filtering window size is increased to have a sufficient number of encrypted pixels in the neighborhood. Depending upon the sliding window mask, there may be many variations of median filters. In this paper, Median filter with sliding window (3×3), (5×5) and (7×7) are reviewed. Applications of the median filter require caution because median filtering tends to remove image details such as thin lines and corners while reducing noise.

In 1998 Scott E Umbaugh [2], author presented mean filter acts on an image by smoothing, it also reduces the intensity variation between adjacent pixels. The mean filter is nothing but a simple sliding window spatial filter that replaces the center value in the window with the average of all the neighboring pixel values including it. By doing this, it replaces pixels that are unrepresentative of their surroundings. It is implemented with a convolution mask, which provides a result that is a weighted sum of the values of a pixel and its neighbors. It is also called a linear filter. The mask or kernel is a square. Often a 3× 3 square kernel is used. If the coefficients of the mask sum up to one, then the average brightness of the image is not changed. If the coefficients sum to zero, the average brightness is lost, and it returns a dark image. The mean or average filter works on the shift-multiply-sum principle.

In July 1993 J.N. Lin, X. Nie, and R. Unbehauen [3], introduced a LMS Adaptive Filter Incorporating a Local-Mean Estimator for Image Processing. An adaptive filter does a better job of de-noising images compared to the averaging filter. The fundamental difference between the mean filter and the adaptive filter lies in the fact that the weight matrix varies after each iteration in the adaptive filter while it remains constant throughout the iterations in the mean filter. Adaptive filters are capable of de-noising non-stationary images, that is, images that have abrupt changes in intensity. Compared to other adaptive filters, the Least Mean Square (LMS) adaptive filter is known for its simplicity in computation and implementation.

In 2006, Krishnan Nallaperumal [4] presented a Selective Switching Median Filter (SSMF) for the Removal of Salt & Pepper Impulse Noise. In this paper, a new median based filtering algorithm is presented for the removal of impulse noise from digital images. A good analysis of the limitations of the top ranking median filters, the Progressive Switching Median Filter, PSMF and the Rank-order based Adaptive Median Filter, RAMF is made and are overcome very effectively by the proposed filter which cleans the impulse corruptions of a digital image in two distinct phases of impulse detection and impulse correction.

In 2007, Krishnan Nallaperumal [5] presented Switching Median Filter for Salt & Pepper Impulse Noise Reduction. An impulse detector which is proposed for switching median filter is based on the minimum absolute value of four convolutions obtained using one-dimensional Laplacian operators. The input image is first convolved with a set of convolution kernels are used, each of which is sensitive to edges in a different orientation. Then, the minimum absolute value of these four convolutions is used for impulse detection, which can be represented as: Similar to other impulse detection algorithms our impulse filter is developed by prior information on natural images, i.e., a noise-free image should be locally smoothly varying, and is separated by edges. The noise considered by this detection algorithm is only salt pepper impulsive noise.

In 2008 Deng Xiuqin [6], presented a new kind of weighted median filtering algorithm used for image Processin, Aimed at the excellence and shortcoming of the traditional median filtering algorithm, this paper proposed a adaptive weighted median filtering (AWMF) algorithm. This new algorithm first determines noise points in image through noise detection, then adjusts the size of filtering window adaptively according to number of noise points in window, the pixel points in the filtering window are grouped adaptively by certain rules and gives corresponding weight to each group of pixel points according to similar it, finally the noise detected are filtering treated by means of weighted median filtering algorithm.

In 2009, S. Balasubramanian [7], presented An Efficient Non-linear Cascade Filtering Algorithm for Removal of High Density Salt and Pepper Noise in Image and Video sequence, in which an efficient non-linear cascade filter for the removal of high density salt and pepper noise in image and video is proposed. The proposed method consists of two stages to enhance the filtering. The first stage is the Decision based Median Filter (DMF), which is used to identify pixels likely to be contaminated by salt and pepper noise and replaces them by the median value. The second stage is the Unsymmetrical Trimmed Filter, either Mean Filter (UTMF) or Midpoint Filter (UTMP) which is used to trim the noisy pixels in an unsymmetrical manner and processes with the remaining pixels [18].

In 2009 S.Esakkirajan [8] presented, an improved version of DBA, it is used to avoid streaks in images that usually occur in DBA due to repeated replacement of the noisy pixel with neighborhood pixels. In case of MDBA noisy pixels are replaced by the median of unsymmetric trimmed output. Drawback of MDBA is that under high noise densities the pixels could be all 0's or all 255's or a combination of both 0 and 255. Replacement with trimmed median value is not possible.

In 2010 K. Aiswarya [9] proposed an efficient algorithm for the removal of high density salt and pepper noise in images and videos, in Second Int. Conf. Computer Modeling and Simulation. To overcome the above drawback, Decision Based Algorithm (DBA) is proposed. In this, image is de-noised by using a 3x3 window. If the processing pixel value is 0 or 255 it is processed or else it is left unchanged. At high noise density the median value will be 0 or 255 which is noisy. In such case, neighboring pixel is used for replacement. This repeated replacement of neighboring pixel produces streaking effect.

In 2013 T.SunilKumar [10], proposed a Removal of high density impulse noise through modified non-linear filter. Various filters are discussed in this paper for removal of noise from gray scale and color images. The values for the comparison of different filters are taken from this paper as a reference. In this method the noisy pixel are replaced by trimmed median value when other pixel are not all 0's or 255's. But if the all the pixel value are 0 or 255 then this method increases the window size and then trimmed median value is calculated and noisy pixel is replaced.

In 2012 Ashwni kumar [11] First Order Neighborhood decision based Median filter The idea behind a trimmed filter is to reject the noisy pixel of the selected 3x 3 window. Alpha Trimmed Mean Filtering (ATMF) is a symmetrical filter where the trimming is symmetric at either end. In this procedure, even the uncorrupted pixels are also trimmed. Alpha-trimmed mean filter is a window fitter of nonlinear class, by its nature is hybrid of the mean and median filters. The basic idea behind the filter is for any element of the signal (image) look at its neighborhood, discard the most atypical elements and calculate mean value using the rest of them. Alpha you can see in the name of the filter is indeed parameter responsible for the number of trimmed elements.

3. PROBLEM STATEMENT

After studying above literature we have find that various filter have been already developed in this area. We will focus our attention on first and second order mean filter, in which we will work on gray as well as color images.

4. FOSMF ALGORITHM:

Step 1: First we take an initial gray/colour image and apply on it fixed valued impulses noise. Let this colour image is Y.

Step 2: In the second step we will divide the noisy image into 2D image of RGB format. By considering Red, Green and Blue component pixels separately for checking noise.

Step 3: Now in third step the red pixel is read and processed by using the following steps:-

Step 3.1: Firstly check whether the pixels are between 0 to 255 ranges or not, here two cases are generated.

$X(i,j) = 0 < l(i,j) < 255$ condition true follow Case1

$X(i,j) \neq 0 < l(i,j) < 255$ condition true follow Case 2

Where X (i,j) is the image size and l (i,j) all image targeted pixels.

Case 1- If Pixels are between $0 < l(i,j) < 255$ then, they are noise free and move to restore the image.

Case 2- If the pixel does not lie in the range then they are moved to step 3.2.

Step 3.2: In the second step we will work on noisy pixel of step3.1 now select a window W(i, j) of size 3 x 3 of image and subtract centre pixel value from remaining pixels which is known as first oredr difference. Assume that the targeted noisy pixels are X (i,j), that is processed in the next step. Also we can use second arder difference for detection of corrupted pixel.

Step 3.3: If the preferred window contains not all elements as 0's and 255's and if any difference is greater than predefined threshold. Then remove all the 0's and 255's from the window, and send to restore the image. Now find the mean of the remaining pixels. Replace X (i,j) with the mean value. This noised removed image restores in de-noised image at the last step.

Step 4: Repeat steps 3.1to 3.3 green and blue pixels and green pixels the noisy pixel are represented by m(i,j) and for blue the noisy pixel are represented by n(i,j). Also the restored image is represented by Y(i,j) and Z(i,j) respectively.

Step 5: Whole process is performed until all pixels red, green and blue in the whole image are processed. And finally the de-noised images are joined to get the final de-noised image.

These steps we can present via flowchart for the proposed algorithm. Hence a better de-noised image is obtained with improved PSNR, minimum MSE and better IEF and also shows a better image with very low blurring and improved visual and human perception.

Table 1: Comparison of PSNR values of different existing filters for Lena image:

De-Noising Methods	Noise Density %				
	10%	20%	30%	40%	50%
MF [11]	28.493	25.754	21.846	18.407	14.734
AMF [11]	21.984	21.929	21.473	21.473	20.654
DBA [11]	36.756	33.260	30.565	28.260	26.284
MDBA [11]	36.756	33.260	30.530	28.298	26.250
MDBUTMF [11]	38.129	34.600	32.142	32.088	28.217

where Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) is given by equations below respectively:

$$MSE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}\{Y(i,j) - \hat{Y}(i,j)\}^2}{m\ x\ n}$$

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

Where Y(i,j) is original image and Y(i,j) is reconstructed image.

Flow Chart of Proposed Method:

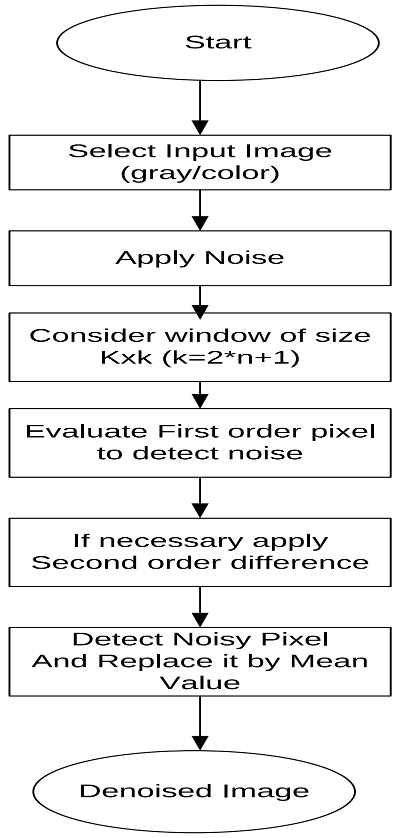

Figure 1. Flow chart of image denoising

5. CONCLUSION

FSOFM filter algorithm for effective removal of impulse noise is presented in this paper. This filter is able to suppress high density of impulse noise, at the same time preserving fine details, textures and edges. Extensive simulation results verify its excellent impulse detection and detail preservation abilities by attaining the highest PSNR and lowest MAE values across a wide range of noise densities. In addition, the relatively fast runtime and simplicity in implementation, both for monochrome and color images denoising, as compared to other state-of-the-art filters demonstrate the tremendous importance of the proposed FSOMF filter towards image applications in consumer electronic products.

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