Advanced Intelligence System To Remove Salt & Pepper Noise By Modified Median Filter: A Survey

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Abstract—. Isolating or reducing salt & pepper noise is a vast attractive research in image processing. Removing impulse noise is believed to be very important in the domain of image regression, but it is a certain more challenging area than isolating pure noise. Hence, relatively lesser works have been done in this area. In this paper the Back Propagation ANN based novel approach has been represented for reducing the salt and pepper noise from the high density impulse noisy images, using Advanced Modified Back Propagation Artificial Neural network based Unsymmetric Trimmed Median Filter. The existing MDBUTMF is unable to restore the original image from the noisy images, if noise density is higher than 75%. The performance of the new method is analyzed by using different qualities of metrics, such as Mean Square Error (MSE) and Peak Signal to Noise ratio (PSNR). All simulation results distinctly show that the new method performs better both in qualitative as well quantitative fidelity criteria, when it is compared with MDBUTMF.

Keywords—image processing, salt & pepper noise, median filter, noise density, PSNR, MSE

I. INTRODUCTION

Image De-noising is one of the fundamental problems in image processing and computer vision. The major concern in image processing is estimation of pixel values. For example, interpolation or resizing is to estimate plausible pixel values located between known ones while de-noising or de-blurring is to estimate clean pixel values from corrupted ones.

Filling missing parts of an image in order to obtain a visually plausible outcome is the problem addressed in three distinct but related fields of study [1]. Image de-noising is an important image processing task, both as a process itself, and as a component in other processes. Very many ways to de-noise an image or a set of data exists. The main property of a good image de-noising model is that it will remove noise while preserving edges. Traditionally, linear models have been used. One common approach is to use a Gaussian filter, or equivalently solving the heat-equation with the noisy image as input-data, i.e. a linear, 2nd order PDEmodel [2]. For some purposes this kind of de-noising is adequate. One big advantage of linear noise removal models is the speed.

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But a drawback of the linear models is that they are not able to preserve edges in a good manner: edges, which are recognized as discontinuities in the image, are smeared out. Nonlinear models on the other hand can handle edges in a much better way than linear models can. One popular model for nonlinear image de-noising is the Total Variation (TV) filter, introduced by Rudin, Osher and Fatemi. This filter is very good at preserving edges, but smoothly varying regions in the input image are transformed into piecewise constant regions in the output image [3].

The noisy pixel is replaced by the median/mean/mid-point value of the window or by its neighborhood values. For high density salt and pepper noise it might so happen that the replaced pixel (median/mean) might be a noisy pixel which does not help in suppression of noise. The Modified Decision Based Unsymmetric Trimmed Median Filter replaces the noisy pixel by the trimmed median value (excluding the either 0 or 255 the noise pixel is replaced by the mean value of all the elements present in the current window [4].

Image denoising is an important image processing task, both as a process itself, and as a component in other processes. Very many ways to denoise an image or a set of data exists. The main properties of a good image denoising model are that it will remove noise while preserving edges. Traditionally, linear models have been used. One common approach is to use a Gaussian filter.

For filtering other than Gaussian filter we have used Gabor filter, box filter, median filter, adaptive median filter.possible , such as "box" or "cross" patterns. Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes database of normal anatomy and physiology to make it possible to identify abnormalities.
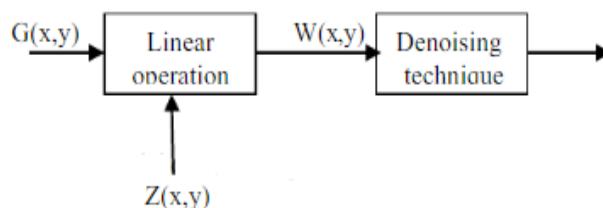

Figure 1: Denoising Model

II. DIFFERENT SORCES OF IMAGE NOISE

Noise is introduced in the image at the time of image acquisition or transmission. Different factors may be responsible
for introduction of noise in the image. The number of pixels corrupted in the image will decide the quantification of the noise. The principal sources of noise in the digital image are:
a) The imaging sensor may be affected by environmental conditions during image acquisition.
b) Insufficient Light levels and sensor temperature may introduce the noise in the image.
c) Interference in the transmission channel may also corrupt the image.
d) If dust particles are present on the scanner screen, they can also introduce noise in the image.

DIFFERENT TYPES OF NOISE :-
Noise is the undesirable effects produced in the image. During image acquisition or transmission, several factors are responsible for introducing noise in the image. Depending on the type of disturbance, the noise can affect the image to different extent. Generally our focus is to remove certain kind of noise. So we identify certain kind of noise and apply different algorithms to remove the noise. Image noise can be classified as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), Film grain, on-isotropic noise, Multiplicative noise (Speckle noise) and Periodic noise.

Impulse Noise (Salt and Pepper Noise): The term impulse noise is also used for this type of noise [5]. Other terms are spike noise, random noise or independent noise. Black and white dots appear in the image [6] as a result of this noise and hence salt and pepper noise. This noise arises in the image because of sharp and sudden changes of image signal. Dust particles in the image acquisition source or over heated faulty components can cause this type of noise. Image is corrupted to a small extent due to noise. Show the effect of this noise on the original image (Fig 2).
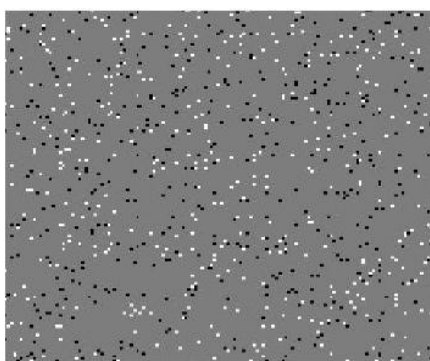
Figure 2: Salt and pepper noise

Gaussian Noise (Amplifier Noise): The term normal noise model is the synonym of Gaussian noise. This noise model is additive in nature [7] and follow Gaussian distribution. Meaning that each pixel in the noisy image is the sum of the true pixel value and a random, Gaussian distributed noise value. The noise is independent of intensity of pixel value at each point.
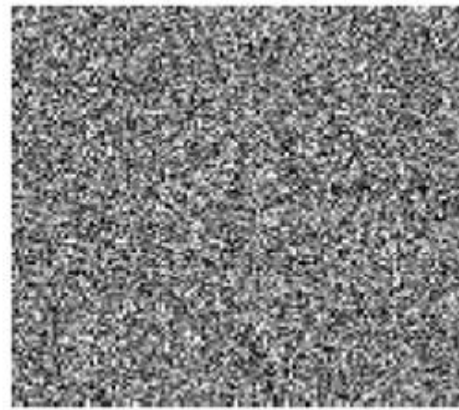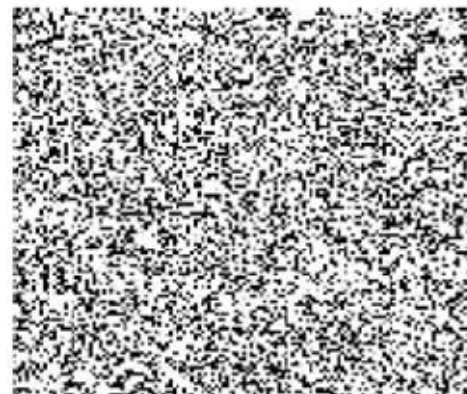
Figure 3: Gaussian Noise
(mean=0, variance=0.05)

Figure 4: Gaussian Noise
(mean=1.5, variance= 10)

Speckle Noise: This noise is originated because of coherent processing of back scattered signals from multiple distributed points. In conventional radar system this type of noise is noticed when the returned signal from the object having size less than or equal to a single image processing unit, shows sudden fluctuations.

Figure 5: Speckle noise

Image de-noising is very important task in image processing for the analysis of images. Ample image de-noising algorithms are available, but the best one should remove the noise completely from the image, while preserving the details. De-noising methods can be linear as well as non-linear. Where linear methods are fast enough, but they do not preserve the details of the images, whereas the non-

linear methods preserve the details of the images. Broadly speaking,

De-noising filters can be categorized in the following categories:

o Adaptive Filter
o Order Statistics Filter
o Mean Filter
o Averaging
o Median Filter

Adaptive Filter:- These filters change their behavior on the basis of statistical characteristics of the image region, encompassed by the filter region.BM3D is an adaptive filter. It is a nonlocal image modeling technique based on adaptive, high order group-wise models. This de-noising algorithm can be divided in three steps [7-8]:

1. Analysis. Firstly similar image blocks are collected in groups. Blocks in each group are stacked together to form 3-D data arrays, which are de-correlated using an invertible 3D transform.

2. Processing. The obtained 3-D group spectra are filtered by hard thresholding.

3. Synthesis. The filtered spectra are inverted, providing estimates for each block in the group. These block-wise estimates are returned to their original positions and the final image reconstruction is calculated as a weighted average of all the obtained block-wise estimates.

Order Statistics Filter:- Order-Statistics filters are non-linear filters whose response depends on the ordering of pixels encompassed by the filter area. When the center value of the pixel in the image area is replaced by 100th percentile, the filter is called max-filter. On the other hand, if the same pixel value is replaced by 0th percentile, the filter is termed as minimum filter. In this filtering technique, the pixel is replaced with the median of the neighboring pixels. A window is chosen, which vary for the 1D signal and 2D signals, and the window slides over each pixel value. Some issues with median filter includes that the majority of the computational effort and time is spent on calculating the median of each window.

Mean Filter:-
Mean filter is an averaging linear filter [6]. Here the filter computes the average value of the corrupted image in a predecided area. Then the center pixel intensity value is replaced by that average value. This process is repeated for all pixel values in the image.

Averaging Filter:-
The averaging filter is used to restoring gray scale and color images highly corrupted by salt and pepper noise and overcoming the drawback of mean filter. As in mean filter here also first the corrupted pixel is detected and then one of the below case is applied to that pixel:

Case 1: If the selected window contains noisy pixel (255 or 0) and all the neighboring pixel values are also noisy pixels, then their median value will also be noisy. Hence to avoid this, the mean is calculated of the pixels in the selected window and the noisy pixel is replaced by that value.

Case 2: If the selected window contains noisy pixel (255 or 0) and some of the neighboring pixel values are noisy, then their median value will also be noisy. Hence to remove noise from the image, 1-D array of the selected image region is obtained so that the 0/255 values will be eliminated and after this the median of remaining values is calculated and the noisy pixel value is replaced by this value.

Case 3: If there is no noisy pixel in the selected window, then no changes are done and the pixel value is left unchanged. This algorithm shows better results than the other filters but the drawback is that it leads to blurring of the image at higher noise densities.

Median Filter:-
Median filter is a best order static, non- linear filter, whose response is based on the ranking of pixel values contained in the filter region. Median filter is quite popular for reducing certain types of noise. Here the center value of the pixel is replaced by the median of the pixel values under the filter region [9] [10]. The median filter is a non-linear filtering technique which is used to remove noise. In this filtering technique, the pixel is replaced with the median of the neighboring pixels. A window is chosen, which vary for the 1D signal and 2D signals, and the window slides over each pixel value. Some issues with median filter includes that the majority of the computational effort and time is spent on calculating the median of each window. As the filter must process every entry in the signal therefore for large signals, the efficiency of median calculation is a critical in determining how fast the algorithm can run. Also median filter is only effective at low noise densities and fails at higher noise densities

III. MEDIAN FILTER

The proposed Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) [6] algorithm processes the corrupted images by first detecting the impulse noise. The processing pixel is checked whether it is noisy or noisy free. That is, if the processing pixel lies between maximum and minimum gray level values then it is noise free pixel, it is left unchanged. If the processing pixel takes the maximum or minimum gray level then it is noisy pixel which is processed by MDBUTMF. The steps of the MDBUTMF are elucidated as follows.

Step 1: Insert 0's to the first row, First column and last row, last column of the image.

Step 2: Select a window of size 3×3, and consider the processing pixel is pij in the window.

Step 3: Processing the corrupted image:
If the processing pixel value lies between $0 < P_{ij} < 255$, then it is an uncorrupted pixel and its value is left unchanged.

Step 4: if $P_{ij} = 0$ or 255, then P_{ij} is a corrupted pixel. The possible cases of processing the pixel:
Case (i): If the selected window contains all 0's and 255's, then P_{ij} is replaced with mean of the element of the window.
Case (ii): If all the elements in the selected window does not have 0's and 225's,
Eliminate 0's and 255's, sort in the ascending order and find the median value of the remaining elements. Replace pij with the median value.

Step 5: Repeat steps 2 to 4 until all the pixel in the entire image is processed.

Step 6: Repeat steps 2 to 5.

Step 7: Remove additionally inserted rows & columns of 0's in step 1.

IV. IMAGE RECONSTRUCTION

In super resolution process image reconstruction or we can say restoration is final and very crucial step. It removes blurring effect and also the noise present in the image. The general model or principle can be represented as

$$g(x, y) = h(x, y) * f(x, y) + n(x, y)$$

Where $g(x, y)$ is the low resolution image, $h(x, y)$ is PSF (point spread function), $f(x, y)$ is the high resolution ideal image, $n(x, y)$ is noise present in the image.

Fourier transforms (FT) of equation 1 is given by

$$G(u, v) = H(u, v)F(u, v) + N(u, v)$$

Super resolution (SR) restoration is to perform analytic continuation to $F(u, v)$ to extend its support domain by applying prior information and posterior processing technologies.

Now get new point spread function (PSF)H' (u, v). H(u, v) also has the extended support domain; therefore the resolution of the image is enhanced. There is usually very small prior information in images and the point spread function of the image is tedious to get, so blind deconvolution is most probably used to reconstruct the image.

Typical blind deconvolution are of two types

1) The recognition of point spread function is separated with the restoration of image. Point spread function (PSF) is obtained first, after that traditional restoration methods are used to compute the estimate of original image.
2) The recognition of PSF (point spread function) and restoration of image are performed at the same time, so this kind of method is very complex.

Beside this there are some other approach which are widely used in blind deconvolution are Auto Regressive Moving Average and Priori Blur Identification method.

Fig 6 Image after restoration

VI. CONCLUSION

In general, a new algorithm Advanced modified decision based unsymmetrical trimmed median filter (**AMDBUTMF**) is proposed and developed for different de noising images of different format. Whereas, averaging and minimum filters performed worst. Median filter is the best choice of removing the Salt and pepper noise. In further work of my dissertation is modified median filter and improved PSNR (peak signal noise ratio) and reduced mean square error (MSE) for gray an color image.

The performance of this method is tested for different noise densities with gray scale images. Particularly at high noise densities the proposed method is better in removing the effect of noise. This method is also applicable for another type of noises like speckle, Gaussian, random etc.

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