ADVANCED CNN BASED MEDIAN FILTER TECHNIQUE FOR REMOVAL OF SALT AND PEPPER NOISE: A SURVEY

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Abstract—. Face images are used in a variety of applications in digital image processing, including identity and authentication of people, emotion recognition and categorization, and numerous security-related activities. The study of really well noise removal filters for removing salt and pepper noise mostly in spatial domain is included in this study. Isolating or decreasing salt and pepper noise is a fascinating area of image processing study. In the field of image extrapolation, eliminating impulse noise is seen to be crucial, although it is a more difficult task than extracting simple noise. As a result, there have been fewer studies in this field. That used an Advanced Convolutional Neural Network focused Unsymmetric Trimmed Median Filter, a CNN based new strategy for minimising salt and pepper noise with high density impulsive noisy images has indeed been proposed in this research. If noise density is more than 75%, the present MDBUTMF is not able to reconstruct original image from noisy images. The novel method's performance is computed using a variety of metrics, including Mean Square Error (MSE) and Peak Signal to Noise ratio (PSNR). Whenever contrasted to MDBUTMF, the simulation outcomes clearly suggest that new technique performed best in both qualitative and quantitative integrity criteria.
Keywords—*image processing, Denoising, salt & pepper noise, trimmed median filter, MSE, PSNR*

I. INTRODUCTION

The one of most basic difficulties in image processing is de-noising. The estimate of image pixels is a fundamental challenge in image processing. Estimation method or scaling, for example, is used to compute reasonable pixel values amongst known ones, whereas de-blurring or de-noising is used to compute clear image pixels from damaged one.

The topic of filling in missing elements of an image for the purpose of achieving a visually realistic result is tackled in three separate but related disciplines of research [1]. The de-noising is a crucial image processing activity, both a standalone procedure and as component of others. There are numerous methods for de-noising an image. The most important feature of a successful image de-noising prototype is that it removes noise while maintaining edges. Linear prototypes have been utilised in the past. The use of a Gaussian filter, or resolving radiative heat transfer with input images as input data, i.e. a nonlinear, 2nd order PDE prototype [2], is a typical strategy. This type of de-noising is sufficient for some needs. The speed of linear noise filtering models is a significant benefit.

However, one disadvantage of linear prototypes is unable to preserve edges well: edges, which are detected as visual discontinuities, are smearing out. Prototypes generally, on other hand, are far better at dealing with edges than linear programming. The Total Variation Filter (TVF), developed by Rudin, Osher, & Fatemi, is a prominent filter for linear image de-noising. Although this filter does a decent job of maintaining edges, it also transforms smoothly variable parts in input image to piecewise areas in image [3].

The window's median or its neighbourhood values are used to substitute noisy pixel. When dealing with salt and pepper noise with high-density, it's possible that substituted pixel (mean/median) is a chaotic pixel that doesn't help with noise reduction. The Unsymmetric Modified Decision Based Trimmed Filters substitutes the noise pixel with trim median value (not including either 0 or 255). The average value of all items in the selected window replaces the noisy pixel [4].

Denoising images is a crucial image processing operation, both as standalone procedures and as component of other processes. There are numerous methods for denoising an image or a piece of data. The essential characteristics of a successful picture denoising model are its ability to eliminate noise while maintaining edges. Linear models have been utilised in the past. The employment of a Gaussian filter is a frequent method.

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We used Gabor, box, median, and adaptive median filters in addition to the Gaussian filter for filtering. Patterns like "box" and "cross" are feasible. The methods and practise of creating images of the internal of the body for clinical examination and medical assistance is known as medical imaging. Medical imaging targets to expose hidden interior structures beneath the skin and bones, as well as diagnose and cure disease. CT scan also generates a database of normal anatomy and physiology, allowing anomalies to be detected.

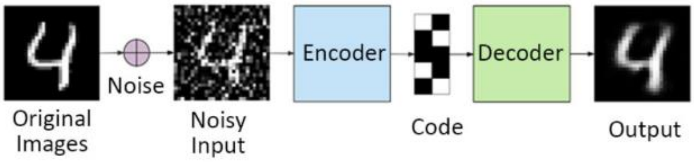

Figure 1: Denoising Model

II. DIFFERENT SORCES OF IMAGE NOISE

At the time of images acquired or transfer, noise is originated into the image. The introduction of noise in an image can be caused by a variety of circumstances. The noise will be quantified based on the amount of corrupted pixels. The following are the main types of noise in digital images: a) During picture acquisition, the imaging sensor may be impacted by ambient circumstances.

b) Image noise may be introduced by inadequate levels of light and sensor heat.

c) Image corruption can also be caused by interference in the data transmission.

d) If there are dust on scan screen, they could cause noise from image.

DIFFERENT TYPES OF NOISE:-

The negative impacts produced in image are termed to as noise. Several variables help with the beginning of noise into an image during capture or transmission. Noise can have variable degrees of effect on image depending on sort of disturbance. Our main target is to eliminate specific kind of noise. As an outcome, we detect different kinds of noise and employ a variety of techniques to remove it. Impulse noise (Salt-and-pepper sound), Amplification variation (Gaussian noise), Shot noise, Quantization noise (uniform noise), Film grit, on-isotropic loud sounds, Multiplicative noise (Speckle noise), and Cyclic noise are some of the several types of image sound.

Impulse Noise (Salt and Pepper Noise): This form of noise is also known as random - valued impulse [5]. Spike noise, random noise, and autonomous noise are other words for the same thing. As a result of this sound, black and white dots form in image [6], resulting in salt and pepper noise. Sharp and rapid fluctuations in visual signal cause this noise to present in image. This type of noise might be created by dusty granules in image acquisition sources or overheated deficiencies components. Due to noise, the image is slightly distorted. Demonstrate how this noise affects the actual image (figure 2).

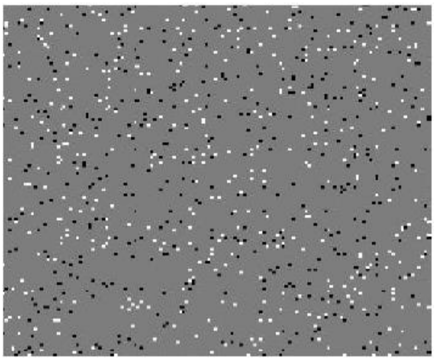

Figure 2: Salt and pepper noise

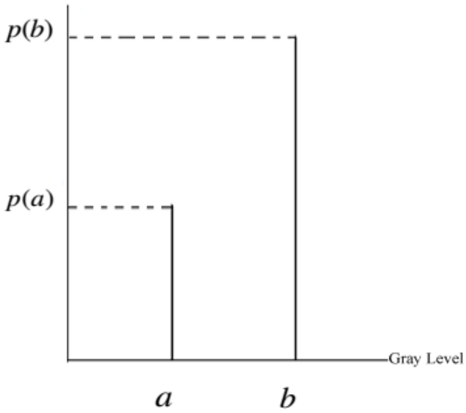

Figure 3: PDF of Salt and pepper noise

Gaussian Noise (Amplifier Noise): The terms normal noise prototype and Gaussian noise are interchangeable. This noise model follows a Distribution function and is likely to increase over time [7]. In the input images, each pixels is combination of true image pixel and a randomized, Gaussian dispersed noise component. The noise is unaffected by the pixel value's intensity at each position.

Gaussian distribution is another name for it. It has a normally distributed probability density (PDF). During images acquired, this noise is introduced to the image, such as sensor noise generated by poor light, high temperature, or transmission, such as circuitry noise. By smoothing the image (mean filtration, wiener filter, and gaussian flattening), this noise can be removed, however smoothing also distorts the perfectly alright image edges and details. It can also be removed by using discrete cosine transform to the noisy image, such as the wavelet. The following formula and graphic [1] show the PDF of Gaussian Filter:

$$p(z) = \frac{1}{\sqrt{2\pi\sigma}} e^{-(z-\mu)^2/2\sigma^2} \qquad (1)$$

PDF of Gaussian noise [1] is depicted in Figure 3

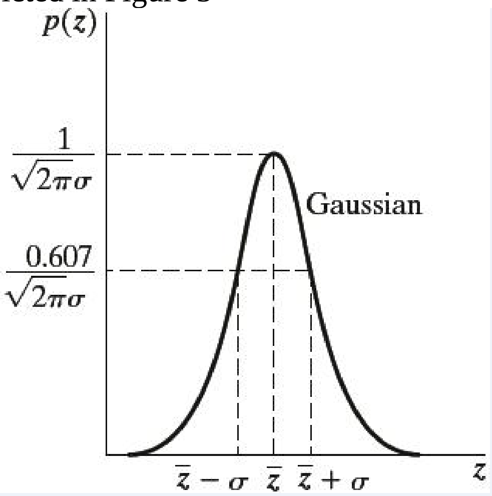

Figure 4: PDF of Gaussian Noise

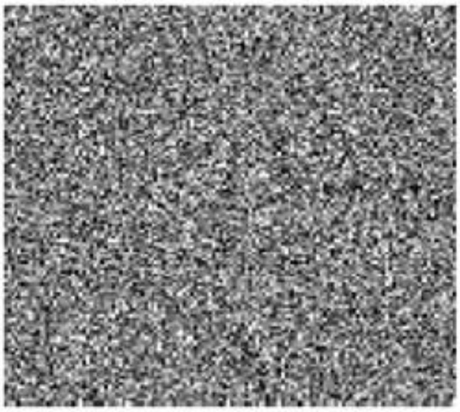

Figure 5: Gaussian Noise
(mean=0, variance=0.05)

Speckle Noise: This noise is caused by the processing of backscattered data from several distributed sites in a coherent manner. When the transmitted signal from an item with a size smaller than or equivalent to single image processing unit depicts abrupt oscillations in a traditional radar system, this form of noise is detected.

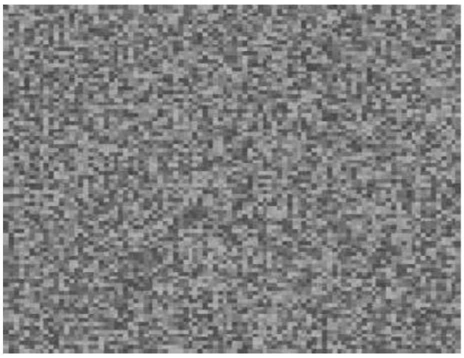

Figure 6: Speckle noise

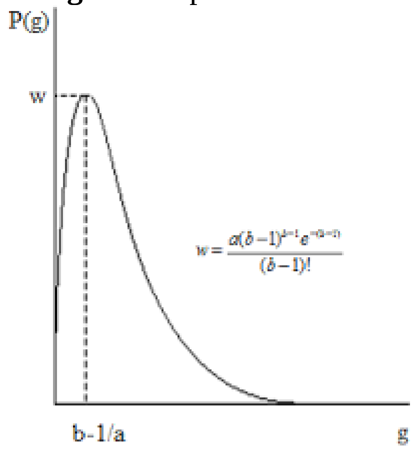

Figure 7: PDF of Speckle noise

III. DIFFERENT TYPES OF FILTERS

For image interpretation, image de-noising is a crucial step in the image processing. There are a plethora of image de-noising algorithms to choose from, but the optimal one should remove all noise in image whilst maintaining all information. De-noising techniques can be both linear and non-linear. Whereas linear approaches are quick, but they don't maintain image details, non-linear techniques do. De-noising filters may be generally classified into following categorized as follows:

- Adaptive Filter
- Order Statistics Filter
- Mean Filter

- Averaging
- Median Filter

Adaptive Filter:- The empirical properties of image region enclosed by filter region influence the behaviour of these filters. BM3D is a filter that adapts to the environment. It's an approach for nonlocal picture modelling that uses adaptive, high-order group-wise models. There are three steps to this de-noising method [7-8]:

1. Examine. To begin, comparable image blocks are grouped together. Each group's pieces are stuffed to create 3-D data array, that are then de-correlated utilizing an integrable 3D transformation.
2. Preparation. Hard thresholding is used to filter the resultant 3-D group spectra.

Synthesis is the third step. Inverting the filtered spectra yields estimates for each block in the group. The final picture restoration is determined as weighted average of all collected block-wise estimations, and they are returns to its original **places**.

Order Statistics Filter:- Filters are non-linear filters where output is determined by the order of pixels in the filter region. The filter is called max-filter whenever the centre value of each pixel in image region is replaced with the 100th percentile. The filter is called a minimal filter when the same pixel value is substituted by the 0th percent. The pixel is substituted by the median of the neighbouring pixels in this filtering approach. A window is selected, which differs for 1D and 2D signals, and it moves across each pixel value. The majority of computing effort and time is devoted computing median of each window, which is one of the problems with the median filter.

Mean Filter:-

The mean filter is a nonlinear averaging filter [6]. In this case, the average value of distorted image in predetermined area is computed by this filter. The average value is being utilized to substitute the centre pixel's intensity value. This procedure is done for each of the image's pixel values.

Averaging Filter:-

The averaging filter is utilized to restore grayscale and colour images that have been heavily distorted by salt and pepper noise while also trying to overcome the disadvantages of the average filter. As with the mean filter, distorted pixel is recognised first, and then one of following cases is applied to it:

Case 1: If a noisy pixel (255 or 0) is present in the specified window, and all of nearby pixel values are likewise noisy, the screen's median value would be noisy as well. To prevent this, mean of pixel in current window is calculated, and noisy pixel is substituted with that number.

Case 2: If a noisy pixel (255 or 0) is present in the specified frame, and several of nearby image pixels are also noisy, then their median price shall be noisy as well. To reduce noise from an image, a 1-D array of chosen image region is produced, with the 0/255 values removed, and the median of the residual values computed, with noisy pixel value substituted by this value.

Case 3: If none of noisy pixels are found in specified window, no adjustments are made and pixel value remains unchanged. This technique produces better outcomes than other filters, but it has the disadvantage of causing image blurring at larger noise concentrations.

Median Filter:-

The mean filter is a non-linear, best-order static filtering whose output is determined by ranking of pixel values inside filter zone. The median filter is widely used to reduce noise in specific situations. The median of image pixels under filter region [9] [10] replaces the pixel's centre value. The median filter is a non-linear filter method for noise reduction. The pixel is replaced by median of neighbouring pixels in this filtering approach. A window is selected, which differs for 1D and 2D signals, and it moves across each pixel value. The bulk of the computing time and effort is spent computing the median of each frame, which is one of the problems with the median filter. Because the filter must evaluate each entry in the signal, efficiency of median computation is essential in exhibiting how fast algorithm may run for huge signals. In addition, the median filter works well at low noise densities and failure at greater densities.

IV. MEDIAN FILTER

The suggested Modified Decision Based Free - free Trimmed Median Filter (MDBUTMF) [6] algorithm first detects the impulse noise and then analyses the distorted images. The processing pixel is examined to see if it’s noisy or noiseless. That is, if processed pixel was between min and max grey level values, it is a noise-free image and should be left alone. It is a noisy pixel that is handled by MDBUTMF if the processor pixel reaches the maximum or minimum grey level. The MDBUTMF is broken down into the following phases.

Step 1: Put 0s in the picture's first-row, first-column, and last-row, last editorial.
Step 2: Choose a window with a size of 33 pixels and assume that processing pixel is pij in the frame.
Step 3: If the processed number of pixels is somewhere between 0 and Pij255, it is an uncorrupted pixels, and its meaning is left unaltered.
Step 4: Pij is a corrupted pixel if it equals 0 or 255. The following are examples of image processing scenarios:

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,

Remove the 0s and 255s, sort the attribute in increasing order, and find the median value. Pij should be replaced with the median value.
Step 5: Repeat steps 2–4 until every pixel in image has been processed.
Step 6: Steps 2 through 5 should be repeated.
Step 7: Step 1: Remove any extra inserted rows and columns of 0s.

V. IMAGE RECONSTRUCTION

Image reconstruction, or restoration, is the final and most important phase in the super resolution process. It removes the blurring effect as well as any noise in image. The general prototype or principle is as follows:

$$g(x, y) = h(x, y) * f(x, y) + n(x, y) \qquad (2)$$

Where g(x, y) denotes a reduced image, h(x, y) denotes a point spread function, f(x, y) denotes a high-resolution ideal image, and n(x, y) denotes image noise.

Equation 3's Fourier transformations (FT) are given by

$$G(u, v) = H(u, v)F(u, v) + N(u, v) \qquad (3)$$

The goal of super resolutions (SR) restoration is to use prior information and posterior processing techniques to F(u, v) to increase its supporting domain.

Get a new point up and share (PSF) called H' now (u, v). H(u, v) also has an expanded support domain, which improves the image's resolution. Due to the lack of prior information in an image and the difficulty in obtaining the image's point spread function, blind discrete wavelet transform is most likely utilised to rebuild the image.

There are two forms of blind franchised.

1) The recovery of the image is isolated from the recognition of the point spread function. After obtaining the cumulative distribution function (PSF), standard restoration techniques are employed to construct an estimate of the main image.

2) Because the identification of the PSF (point spread functional) and image restoration are done at same instant, this technique is somewhat complicated.

Aside from that, the Auto Regressive Becomes At and Priori Blur Identification methods are two other approaches that are commonly employed in blind wavelet decomposition.

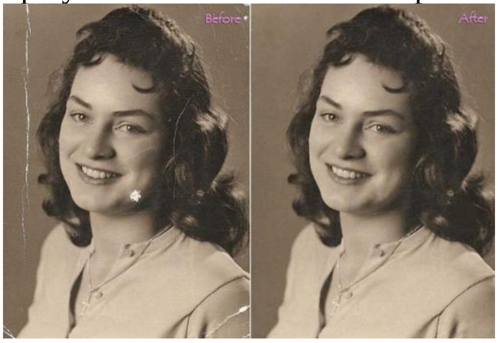

Figure 8: Image after restoration

VI. Conclusion

A algorithm is developed, in general, The CNN-AMDBUTMF (CNN-advance modification judgement asymmetric trim median filter) is suggested and implemented for various denoising images of various formats. Averaging and minimum filters, on the other hand, fared poorly. When it comes to reducing salt and pepper sounds, the median filter is the best option. Modified thresholding, better PSNR (peak signal - to - noise ratio), and reduced mean square error (MSE) for grey and colour images are part of my dissertation's future work.

With grey scale images, the method's effectiveness is evaluated for various noise densities. The proposed strategy is superior at reducing effect of noise, especially at high noise concentrations. This method can also be utilized with various types of noises, such as speckle, Gaussian, random, and so on.

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