# COMPARATIVE STUDY OF DENOISING APPROACHES FOR REMOVAL OF SALT AND PEPPER NOISE FOR IMAGE ENHANCEMENT

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**Abstract :** many times Images are contaminated by noise during image acquisition and transmission and we get the low-quality images as resultant image. Thus, removing of noise before using the images for subsequent analysis tasks is essential process. In this paper, different image denoising algorithms are discussed for salt & pepper noise. Salt & pepper noise is known as impulse noise which is scattered throughout the image. This noise can be caused by sharp and abrupt disturbances in the image signal. It presents itself as sparsely occurring white and black pixels. Image denoising algorithms are applied to the captured image data and detach the noise, thus preserve the integrity of fine image structure. In this paper, various denoising algorithms are discussed and compared and we found that the improved median filter is effective noise reduction method and it gives better image visual quality for any images affected by salt and pepper noise. In short, filter approach uses a noisy portion as the basic unit, a modified median method to optimize the repair dataset as well as obtain a better denoising effect, and provides a guideline for future denoising and repair methods.

***IndexTerms*** **- salt &pepper noise, mean, median, image processing, psnr, impulse noise.**

## I. INTRODUCTION

A digital image is a set of finite number of elements. These elements have a particular location and value, which is known as pixel or picture element or image element and pels. The digital image is represented by a single 2- dimensional integer array for a gray scale image and a series of three 2- dimensional arrays for each color bands.

Image restoration means to recover the clean image from the degraded image by removing the unwanted noise.

Image denoising is frequently utilized as a one of important element of the field of photography or distributing where an image was some way or another corrupted yet should be enhanced before it can be used for further processing or print. For this kind of use we have to know a little regarding the corruption procedure so as to build up a model for it. There are many fields in which Image-denoising applications in play a important role such as in space science where the determination confinements are serious, in therapeutic imaging where the physical prerequisites for excellent imaging are required for examining images of interesting occasions, and in medical science for detecting affected area by various diseases and many more areas are there where images are used as primary dataset of information and we have to taking interested information from it, so it is necessary to first we remove the noises from image so we can get the true information from image.

Noise present in the image can be of additive or multiplicative type depending upon how the images are formed. Salt &pepper noise (Impulse noise) is one of the additive types of noise present in the image during signal acquisition stage or due to the bit error in the transmission. There are two types of impulse noise found in the image, they are random value impulse noise and fixed value impulse noise (which is known as Salt and Pepper noise). In salt and pepper noise the corrupted pixels take the maximum (i.e. 255) value or the minimum (i.e. 0) value which leads to white and black spots in the image.

Generally, the removal of salt and pepper noise consists of two problems: (1) how to detect the noisy pixels and (2) how to repair them. In the past decade, a number of denoising algorithms have been developed.

## II. LITERATURE REVIEW

B. Deepa and Dr. M. G. Sumithra, in this paper Noise removal techniques have discussed. Removing of noise from images are essential exercises in image processing applications. In medical field image processing is play important role. The most commonly affected noises in medical image are salt and pepper, Gaussian, Speckle and Brownian noise. In this paper, the medical images taken for comparison include MRI brain images, in gray scale and RGB.

V.Rabila1 and G.Bharatha Sreeja, The idea of this paper is to analyse different methods to produce the better results in terms of PSNR, SNR, and SSIM. Different denoising techniques are discussed in this paper.

Neela Chithirala ; Natasha B. ; Rubini N. ; Anisha Radhakrishnan, in this paper a new algorithm that reduces high density salt and pepper noise from images is introduce. Weighted mean of the nearby pixels are calculation and by help of these calculated value Restoration is completed. Weights are allotting unsymmetrical to pre-processed and un-processed pixels. The quality was judged based on the PSNR value. the essential constraint on the input images to any computer vision technology is its quality. Acquiring noise free digital images is a challenge as it depends on several factors. Developing algorithms to remove noise is one way to improve the image quality. Salt and pepper noise degrades the image. The challenge here is to restore the lost information without distorting the edges. The algorithm restores information for highly corrupted images. Salt and pepper noise are usually filtered with variants of the median filter. This paper provides an alternate way for noise reduction.

Babu G, Sivakumar R and Praveena NLM filter is discussed in this paper. Noise is a surrounded fact in the medical images which may add to the root mean square error and diminish the peak signal to noise ratio. NLM filter is used for the removal of speckle noise and shrinkage rule is used to shrink the content of noise present in the brain images by means of the thresholding method.

Priyanka Punhani et al, this paper shows the application of image denoising method in medical filed.Magnetic Resonance Imaging is most popularly used techniques in clinical diagnosis. During acquisition, image quality is degraded by certain noise and artifacts.

Due to which, it is difficult to interpret important details of user. So it becomes necessary to denoise image. There are various denoising methods available now days.
L. Ramya and N. Sasirekha, "A Robust Segmentation Algorithm using Morphological Operators for Detection of Tumor in MRI, author told about the segmentation as well as denoiseing approach. Image Denoising and Image Segmentation are the two major areas of the medical image processing. The main objective of this paper is to develop a robust segmentation algorithm inorder to detect tumor in 2D MRI brain images. Here we use image denoising as the preprocessing step as noise plays an important role incase of accuracy of affected area of the image, especially in medical diagnostics.
Qingkun Song et al, denoising effect by combining of wavelet transform and mean filter are discussed by authore here. The traditional mean filter in the processing of the image noise lessening can create the image edge information mislay and it make image difficult to understand. The wavelet transformation can repress image noise as well as enhancement it. So they joined different filtering methods for reduction of noise from image. The experiments result proposed technique is superior to simple denoising technique and the existing combination of the denoising technique no matter from visual aspect.
MadhuS. et al., they have proposed improved median filtering algorithm combined with average filtering. To solve the contradiction between the noise reducing effect and the time complexity of the simple median filter algorithm. The algorithm adaptively changes sizes the filter mask according to noise density of the mask. According to the sorting results of the pixel values of filtering window in the neighbourhood, the algorithm uses the median value to replace the original pixel. Experimental results show that this improved algorithm can effectively reduce time complexity and has better denoising effect than the standard median filter algorithm. It has a great application prospect in image processing.Combination of the median filtering with the average filtering, the improved algorithm will be reduce the noise and maintain image details much better.
Shuangteng Zhang et al., thesemethods fail in the presence of impulse noise because the noise is heavytailed. More over the restoration will alter basically all pixels in theimage, including those that are not corrupted by the impulse noise.Recently, non-smooth data-fidelity terms have been used along withedge-preserving regularization to deal with impulse noise. Anisotropic diffusion is also a powerful filter where local image variation ismeasured at every pixel and every point, values are averaged fromneighbor hoods whose size and shape depend on local variation. The basic principle of these methods is numbers of iterations. If more iterationare used it may lead to instability, in addition to edges noise become prominent. The Total Variation (TV) filter which isalso iterative in nature. In the later age of research simple and noniterative scheme of edge preserving and smoothing filters are proposed.[7]
WANG Chang et al., an impulsive noise of low and moderate noise densities can be removed easily by simple denoising schemes available in the literature. A simple median filter works very nicely for denoising impulsive noise of low density and is easy to implement. But the cost paid for it is distorts edges and fine details of an image. The distortion increases as the filtering window size is increased to suppress high density noise. Median Filter is a non linear filtering technique widely used for removal of impulse noise. Despite its effectiveness in smoothing noise the median filter tends to remove fine details when it is applied to an image uniformly. But some specialized median filters such as Weighted Median Filter and Recursive Weighted Median Filter RWMF, Center Weighted Median Filter are proposed in literature to improve the performance of the median filter by giving more weight to some selected pixels in the filtering window.[8]
Chenguang Yan et al. conventional median filtering approach applies the median operation everywhere without considering whether it is uncorrupted or not. As a result, image quality degrades severely. An initiative solution to overcome this problem is to implement an impulse noise detection mechanism prior to filtering ,hence only those pixels identified as corrupted would undergo the filtering process.While those identified as uncorrupted would remain intact. By incorporating such noise detection mechanism or intelligence into the median filtering frame work, so called Switching Median Filters have shown significant performance improvement.[9]
HongJun Li, the most popular approaches for dealing with such noise have been based on median filtering on the rich class of order statistics filters that have emerged from the study of median filters. Recently variations on the median filtering scheme have been shown under various specific signal, noise models, to deliver improved performance relative to the corresponding traditional methods. Examples of some type ofmodified median filters have been proposed are Minimum – Maximum Exclusive Mean Filter (MMEM), Florencio's Conditional Median Filter (CMF), Signal Dependent Rank Order Means (SDROM) filter. The filters have all demonstrated excellentperformance but at the price of significant computational complexity.[10]
Chandni Khan, Prof. Anoop Tiwari, In this paper, various filtering algorithms are discussed and compared and we found that the modified median is better salt and pepper high density removal in MRI image. Medical images convey important information to the doctor about a patient's health condition. Internet transmits these medical images to remote locations of the globe to be examined by expert doctors. But data transmission through Internet invokes noise problems for any image data.
Yuqian Li and Guangda Su, authors propose a neighborhood processor implementation of fixed size kernel median filters. Median filtering is a renowned process used in a extensive assortment of application, specially for the exclusion of salt and pepper noise from image. It can lessen noise efficiently even as maintenance the images outlines.

## III. **DIFFERENT DENOISEING APPROACHE**

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. Image noise can be classified as Impulse noise (Salt-and-pepper noise), Amplifier noise (Gaussian noise), Shot noise, Quantization noise (uniform noise), Multiplicative noise (Speckle noise) and Periodic noise etc.In this paper denoising technique which is used for removal of salt & pepper noise are discussed. Salt and pepper noise is known as impulse noise which is spread out all over the image. 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

Figure 1: Original -image without noise, Image with salt & pepper noise

**KSL Filter:-**

One of the filtering algorithms is KSL filtering algorithm. KSL is nothing but it is the combination of kernal, sobel and low pass filter. Apply the kernel filter to the MRI brain image, where kernel matrix is applied to every pixel in the image. The values have been multiplied; the pixel is changed with SOP. By picking out various kernels, different types of filtering can be applied. This provides LPF and HPF using a kernel. Next pass through sobel filter which performs 2-D spatial gradient measurement on an image. Filtered image is passing through LPF which is best suited for smoothing of an image. This tends to retain the low frequency information with in an image. The KSL filtering technique for MRI is implemented in MATLAB and tested with different synthetic and real clinical images this results in noise removal in different types of MRI images like low SNR MRI, partially parallel MRI and so on.

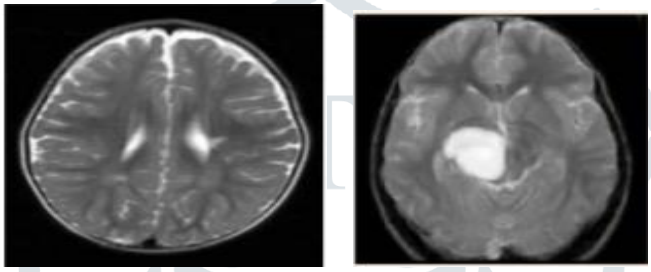

Figure 2: Original-image, image after KSL filtering

**Mean Filter:-** The Mean Filter is a linear filter which uses a mask over each pixel in the signal. Each of the components of the pixels which fall under the mask are averaged together to form a single pixel. This filter is also called as average filter. A mean filter [24] follows up on a image by smoothing it; that is, it diminish the power diversity between adjoining pixels. The mean-filter is only a straightforward sliding window spatial channel that replaces the middle an incentive in the window with the normal of all the neighbouring pixel values including itself. By doing this, it replaces pixels that are unrepresentative of their environment. It is executed with a convolution cover, which gives an outcome that is a weighted total of the estimations of a pixel and its neighbors. It is likewise called a straight channel. The veil or bit is a square. Frequently a 3 x 3 square part is utilized. On the off chance that the coefficients of the cover total up to one, then the normal shine of the picture is not changed. On the off chance that the coefficients total to zero, the normal splend or is lost, and it gives back a dim image. The mean or average filter works on the shift-multiply-sum principle [18]. The white and dark pixel values of the noise are changed to be closer to the pixel values of the surrounding ones. Also, the brightness of the input image remains unchanged because of the use of the mask, whose coefficients sum up to the value one. The mean-filter issued in applications where the noise in certain regions of the image need stobe removed. In other words, the mean filter is useful when only a part of the image needs to be processed. it is useful to remove the gain noise. The Mean Filter is poor in edge preserving. Mask for mean filter is follow

$$\frac{1}{9} \times \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$


Image 3 Original image, image after Mean filtering

**Median Filter:-**

The Median filter is a nonlinear digital filtering method, often used to remove the affect of noise from an image. Such denoising technique is a typical preprocessing step to get better the outcome of post processing (for example, edge detection on an image). It is broadly used method to preserve edges. It is particularly effective at removing salt and pepper noise.

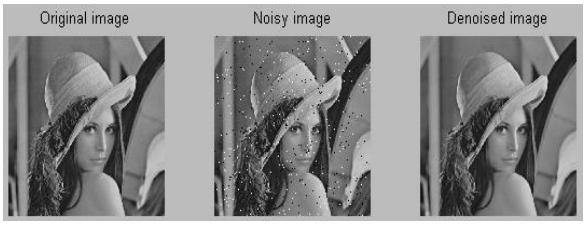


Figure 4: Original image, image after Median filtering

Median filters moving through the image pixel by pixel and put back each value with the median value of neighbouring pixels. The pixel is calculated by first sorting all the pixel values from the pattern of neighbors into mathematical order, and then replacing the pixel being considered by median pixel value. Median filter is superior to remove noise without reducing the sharpness of the image. Median filtering is very widely used in digital image processing because under certain conditions, it preserves edges whilst removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median. The median filter is a robust filter[6]. Median filters are widely used as smoothers for image processing, as well as in signal processing and time series processing. A major advantage of the median filter over linear filters is that the median filter can eliminate the effect of input noise values with extremely large magnitudes. (In contrast, linear filters are sensitive to this type of noise - that is, the output may be degraded severely by even by a small fraction of anomalous noise values) [10].

**Weighted Filtering:**

The second mask is a little more interesting. This mask yields a so-called weighted average, terminology used to indicate that pixels are multiplied by different coefficients, thus giving more importance (weight) to some pixels at the expense of others[10]. In the mask the pixel at the center of the mask is multiplied by a higher value than any other, thus giving this pixel more importance in the calculation of the average.

Weighted Filter mask is as follows:

$$\frac{1}{16} \times \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

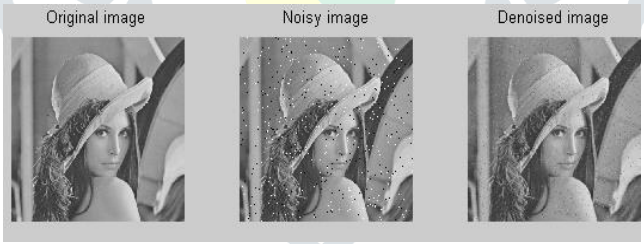


Figure 5: Original image, image after weighted filtering

**Wiener Filter:-**

Wiener filtering carries out an optimal between inverse filtering and noise smoothing. It removes additive noise and deblurring concurrently. This proves to be optimal in reducing the overall Mean Square Error (MSE). The operation involves two parts. One is inverse filtering and the other is noise smoothing. Wiener filters belong to a kind of optimum linear filters with the noisy data as input which involves the calculation of difference between the desired output sequences from the actual output. The performance can be measured using Minimum Mean-Square Error. These filters reduce the amount of noise present in the signal by comparison with an estimation of a desired noiseless signal. It is based on Statistical Approach.


Figure 6: Original image, image after Wiener filtering

**Adaptive Filter:-**

Wiener2 is a 2-D adaptive noise removal filter. The wiwner2 function applies a wiener filter which is a type of linear filter to an image adaptively, tailoring itself to local image variance. Where the variance is large, wiener2 performs little smoothing. Where the variance is small, wiener2 performs more smoothing. This approach often produces better result than linear filtering. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high frequency parts of an image. In addition, there are no design tasks; the wiener2 function handles all preliminary computations, and implements the filter for preliminary computations, and implements the filter for an input image. It is suitable to remove Gaussian noise.


Figure 7: Original image, image after adaptive filtering

## IV. COMPARATIVE STUDY

Various filtering approaches are applied on the images and observe the performance of denoising method. KSL filtering approach is used to remove noise and it gives good quality of result with low signal to noise ratio. In general application it can be used for denoising process but it is not good choice for medical image processing. Wiener filtering carries out an optimal between inverse filtering and noise smoothing. It removes additive noise and deblurring concurrently Mean filter is used to remove the Removing grain noise from an image and gave good output visual information with salt and pepper noise. Another is adaptive filter is require less computational time but output image quality is not good for salt and pepper noise. Weighted average, terminology used to indicate that pixels are multiplied by different coefficients, thus giving more importance (weight) to some pixels at the expense of others. it gives better result than simple average filter because weighted value is used to select the average value of pixel in image. Adaptive Filter approach often produces better result than linear filtering. The adaptive filter is more selective than a comparable linear filter, preserving edges and other high frequency parts of an image Median filtering, Remove the outlier without reducing the sharpness of the image. So performs better with not only general images but with medical space image it give good visual information for image after noise removal. The blurring effect is less as compared with average filter.

## V. CONCLUSION

Median filters are quite popular because, for certain category of random-noise, they provide excellent noise-reduction capabilities, with considerably a smaller amount of blurring effect than linear smoothing filters of similar size. Median filters are efficient to remove the salt & pepper noise with good quality of visual informatation, because of its appearance as white and black dots superimposed on an image it is known as salt-and-pepper noise.

Noise is unwanted information which was contaminating with image and it make difficult to understanding the image real information to user. So reduction of noise from image is very essential to improve the results. In this paper a variety of filtering algorithms are discuss for images which was corrupted by salt and pepper noise. The selection of filter for enhancing the image is very important and how much noise can be reduces with good visual quality of image depends up on the type of the filtering technique, which is used. Among various filters mean filter, average filters are less efficient. Currently, existing algorithms give good results, but theirs efficiency need to be improved. Median filter performs better than other approaches for removing the effect of noise from image. Median approach lessens effect of noise in an image while keeping the edges.

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