

# Speckle, Salt and Pepper Noise Removal for Medical Images using Modified Median Filter

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**ABSTRACT:** In digital Image Processing, removal of noise is a highly demanded area of research. Impulsive noise is common in images which arise at the time of image acquisition and or transmission of images. Impulsive noise can be classified into two categories, namely Salt & Pepper Noise (SPN) and Speckle noise. Removal SPN is easier as compared to Speckle noise due to its characteristics. The present work concentrates on removal of SPN & Speckle from images.

Most of the nonlinear filters used in removal of impulsive noise work in two phases, i.e. detection followed by filtering only the corrupted pixels keeping uncorrupted ones intact. Performance of such filters is dependent on the performance of detection schemes. In this work, thrust has been put to devise an accurate detection scheme and a novel median filtering mechanism.

**KEYWORDS:** Salt Noise, Pepper Noise, Median Filter, High Density

## I. INTRODUCTION

Within seconds of entering the world, those who are blessed with the gift of sight start acquiring images. Human beings are primarily visual creatures, who depend solely on the sense of vision. Vision allows humans to perceive and understand the world surrounding them in a better manner. Processing visual information by the computer has been drawing significant attention of researchers over the last few decades. The process of receiving and analyzing visual information by the human species is referred to as sight, perception or understanding. Similarly, the process of receiving and analyzing visual information by digital computer is called digital image processing [1, 2].

A monochrome image  $I$ , is described as a two-dimensional function can be defined as,

$$I = f(x, y) \quad (1)$$

Where,  $x$  and  $y$  are spatial coordinates. Amplitude of at any pair of coordinates  $(x, y)$  is called intensity  $I$  or gray value of the image. When spatial coordinates and amplitude values are all finite, discrete quantities, the image is called digital image [3]. The digital image  $I$  is represented by a single 2-dimensional integer array for a gray scale image and a series of three 2-dimensional arrays for each colour band (R,G,B) in a color image. The digital images are called bit-maps or raster-scan images, and are composed of an array (grid or matrix) of smaller units called pixels (picture elements). Each pixel in the digital image is a uniform patch of colour but on the display screen is made up of a red, green and blue phosphor dot or stripe. A pixel is the smallest digital image element manipulated by image processing software. Thus, bit maps often show "blocky" areas or jagged lines under close examination.

Image processing has become a pre-cursor for various vision applications. Few such applications are discussed below in nutshell [4].

(a) Biometrics: It is a way of identifying human beings based on certain physiological characteristics i.e. fingerprint, face, DNA, iris, & behavioural characteristics i.e. gait, voice, signature analysis, signature verification etc.

(b) Food quality monitoring: It can be applied in the food processing industry for inspecting the surface of fruits and vegetables to detect their condition and quality for better preservation and utilization.

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(c) Medical imaging: There are many imaging modalities such as X-rays, CT, MRI, PET, Ultrasound and telesurgical applications where robots are controlled to perform surgical operations. It is used for heart disease identification, lung disease identification and digital mammogram (breast tumour detection).

(d) Factory automation: Machine vision system based on image processing and many automation systems are deployed by industries for applications such as visual inspection, surface defect testing, measurements of belt width and edges of blade and knife of surgical instruments, surface quality inspection and fibre analysis. The faulty components can be identified by analyzing the infra-red images.

(e) Remote sensing: The role of image processing in remote sensing applications is quite immense. The sensors capture the pictures of the earth's surface in remote sensing satellites or multi-spectral scanner which is mounted on the aircraft. These pictures are processed by transmitting it to the earth station. Imaging applications include meteorological applications such as weather forecasting and prediction of atmospheric changes; resource mobilization and locating natural resources.

(f) Document image processing: It aims to create a paperless office by capturing the documents in the form of an image. Image archival and retrieval systems effectively archive and help in retrieving the documents such as content-based retrieval systems, image search engines and scripts recognition systems.

## II. MEDIAN FILTER

In sign processing, it's far often proper that allows you to carry out some type of noise reduction on a photograph or sign. The middle sift through is a nonlinear advanced separating system, every now and again used to evacuate commotion. Such clamor rebate is a normal pre-handling venture to enhance the results of later preparing (for instance, side location on a picture). Middle sifting could be generally utilized as a part of computerized photo processing due to the fact, beneath certain situations, it preserves edges even as doing away with noise (however see dialogue under). The guideline idea of the middle get out is to gone through the sign section through get to, supplanting every passage with the middle of neighboring passages. The example of colleagues is known as the "window", which slides, access with the guide of access, over the total flag. For 1D sign, the most extreme clear window is essentially the essential couple of past and taking after sections, while for 2d (or higher-dimensional) cautions including photos, more intricate window examples are reasonable (which incorporate "holder" or "go" designs). Know that if the window has an odd wide assortment of passages, then the middle is anything but difficult to characterize: it is essentially the inside esteem after every one of the sections inside the window is sorted numerically. For an even wide assortment of passages, there is several suitable middle, see middle for additional data.

See that, in the case above, in light of the fact that there is no get to past the principal esteem; the essential expense is rehashed, as with a definitive charge, to procure adequate passages to fill the window. This is one method for adapting to lacking window passages at the hindrances of the flag, yet there are diverse plans that have outstanding houses that may be fancied particularly examples:

- Avoid handling the limits, with or without trimming the flag or picture limit a while later,
- Fetching sections from different places in the flag. With pictures for instance, sections from the far flat or vertical limit may be chosen,
- Shrinking the window close to the limits, so that each window is full.

## III. TYPES OF NOISE

The procedure which attempt to expel the noise from the image and restore the quality of the original image is known as Image Restoration. It is an essential feature in maintaining the quality of the image by using restoring the pixel value. For linear image degradation, Restoration techniques are a model and it is the just opposite process of improving the quality of original image. To find an optimal gauge of the desired outcome restoration technique includes mathematically principle of goodness which accomplishes it.

### Speckle Noise:

Speckle Noise is a multiplicative noise. It is a random signal where the average amplitude increases with the overall signal intensity. It appears as bright specks in the lighter regions of the image.

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It can be modelled as a pixel value multiplied by the random value.  
Speckle Noise can be modelled as

$$I = S + (S * N_g)$$

Where  $N_g$  is the random noise having a zero mean Gaussian probability distributive function.

### Salt and pepper Noise:

It is also known by various names such as shot noise, Impulse noise and binary noise. Salt and pepper noise is a form of noise sometimes seen on images. Noise can be caused by sharp and sudden disturbance in image signal. This noise is mostly caused by sensor & memory problems due to which pixels are assigned incorrect maximum values. The corrupted pixels are set alternatively to the minimum or maximum value & unaffected pixels remain same, giving the image salt & pepper noise like appearance. It presents itself as sparsely occurring white and black pixels. An effective noise reduction algorithm for this type of noise involves the usage of a median filter. Minimum filtering, maximum filtering, mean filtering, rank order filtering are the some other filters which reduced less amount of noise compare to median filter without significantly reducing the sharpness of the image, salt and pepper noise can be reduced.

## IV. MODIFIED MEDIAN FILTER

The Modified Median Filter calculation is the point at which a chose window contains just 0 and 255 esteem then the reestablished esteem is either 0 or 255(again uproarious), drives us to proposed. In this calculation we chose pixel esteem 0 and 255 values then the preparing pixel is supplanted by mean estimation of the chose window. The detail of the calculation is given underneath.

### Algorithm:

Step 1: Select a 3 x 3 matrix size according to the 2-D window size. Assume that the processing pixel is  $P_{ij}$ , which lies at the center of window.

Step 2: If  $0 < P_{ij} < 255$ , then the processing pixel or  $P_{ij}$  is uncorrupted and left unchanged.

Step 3: On the off chance that  $P_{ij} = 0$  or  $P_{ij} = 255$ , then it is considered as tainted pixel and four cases are conceivable as given underneath.

Case 1: In the event that the chose window has all the pixel esteem as 0, then  $P_{ij}$  is supplanted by the Salt clamor (i.e. 255).

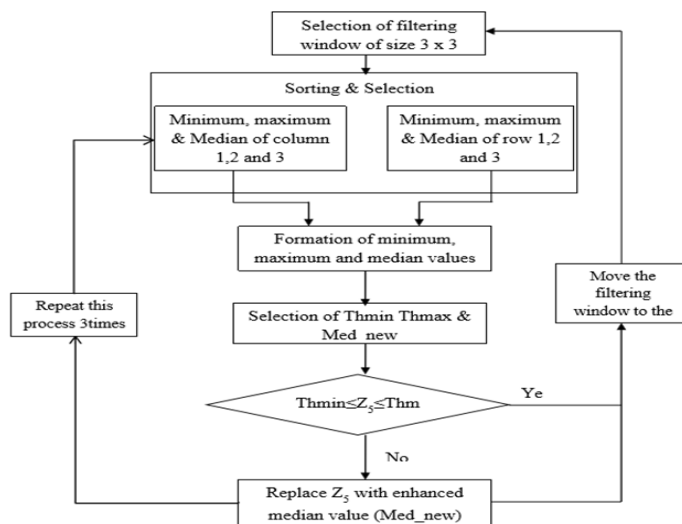


Figure 1: Flow Chart of Proposed Method

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Case 2: On the off chance that the chose window contains all the pixel esteem as 255, then Pij is supplanted by the pepper commotion (i.e. 0).

Case 3: In the event that the chose window contains all the esteem as 0 and 255 both. At that point the handling pixel is supplanted by mean estimation of the window.

Case 4: On the off chance that the chose window contains not all the component 0 and 255. At that point dispose of 0 and 255 and locate the middle estimation of the rest of the component. Supplant Pij with middle esteem.

Step 4: Rehash step 1 to 3 for the whole picture until the procedure is finished.

## V. SIMULATION RESULT

The proposed calculations are tried utilizing 256x256 8bit/pixel picture bike.jpg. In the reproduction, pictures are tainted by Salt and Pepper commotion. The commotion level shifts from 10% to 90% with augmentation of 10% and the execution is quantitatively measured by Mean square Error (MSE) and Peak Signal to Noise Ratio (PSNR).

Mean Square Error (MSE)

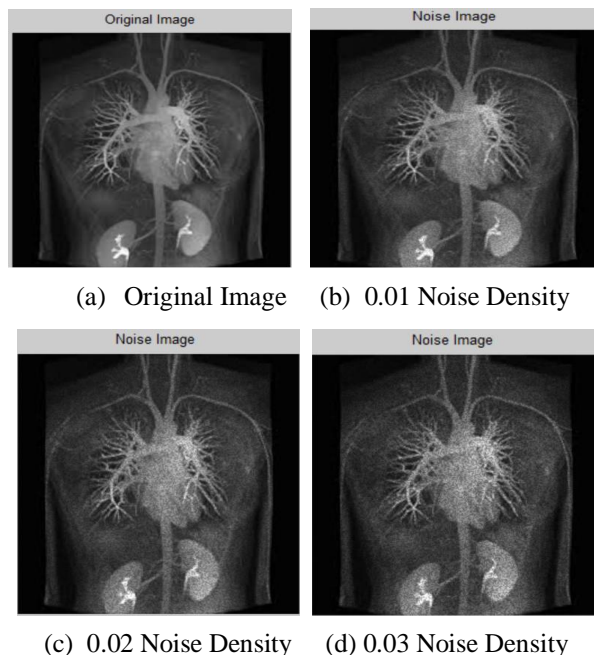
$$= \frac{1}{N_1 N_2} \sum_{j=1}^{N_2} \sum_{i=1}^{N_1} (f(i, j) - g(i, j))^2 \quad (1)$$

Peak Signal to Noise Ratio (PSNR) in dB

$$= 10 \times \log_{10} \left( \frac{255^2}{MSE} \right) \quad (2)$$

Where MSE remains for Mean Square Error, PSNR remains for Peak Signal to Noise Ratio. From the reproduction result appeared in Table I to II, it is watched that the execution of proposed calculation is enhanced PSNR than the current calculations at medium and high clamor level.

The results in the Table 1 clearly show that the PSNR of different method is much better at high density of salt and pepper noise. As the density of noise increasing, the response of proposed filter is becomes better in comparison of other filters.



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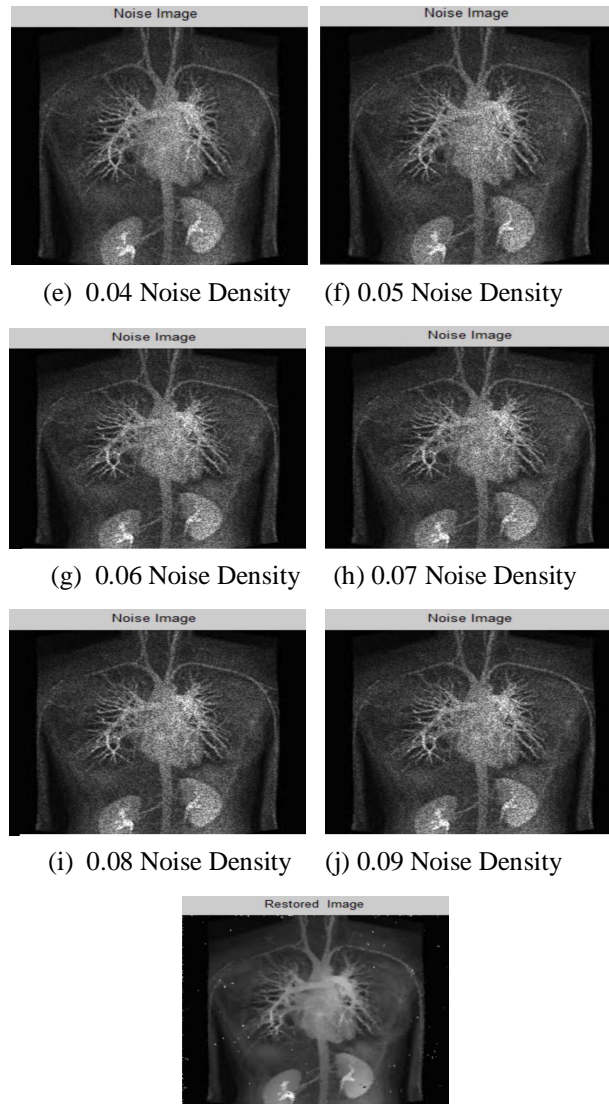


Figure 2: Experimental Speckle Noise Image for Different Noise Density

Table 1: PSNR and MSE Value for Different Noise Density

Image Density	MSE	PSNR (dB)
0.01	0.7640	49.2998
0.02	1.3754	46.7465
0.03	1.9929	45.1359
0.04	2.4775	44.1906
0.05	3.3191	42.9207
0.06	4.0572	42.086
0.07	4.4223	41.6743
0.08	5.4013	40.8058
0.09	5.4709	40.7502

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Table 2: Comparison Result

Filter	PSNR (dB)	MSE
Previous Algorithm	25.07191	203.8369
Proposed Algorithm	40.7502	5.4709

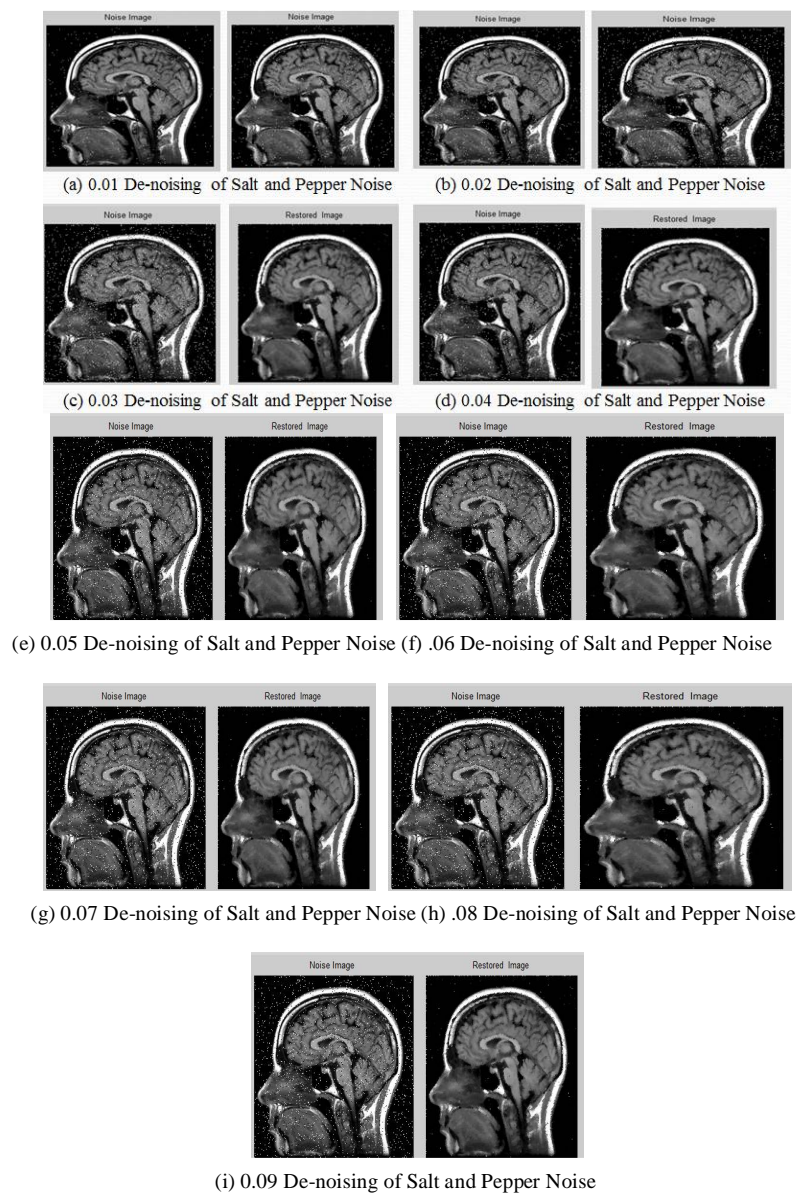


Figure 3: Experimental Results of Proposed Method for real Head Image

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Table 3: Comparison of PSNR of Different Density for Head Image

Density	Previous Algorithm et al.	Proposed Modified Median Filter
0.01	32.36	50.1434
0.02	29.54	47.0639
0.03	27.84	45.2262
0.04	26.55	43.8404
0.05	25.42	42.8793
0.06	24.42	39.999
0.07	23.39	38.4161
0.08	22.37	37.5612
0.09	21.19	36.2986

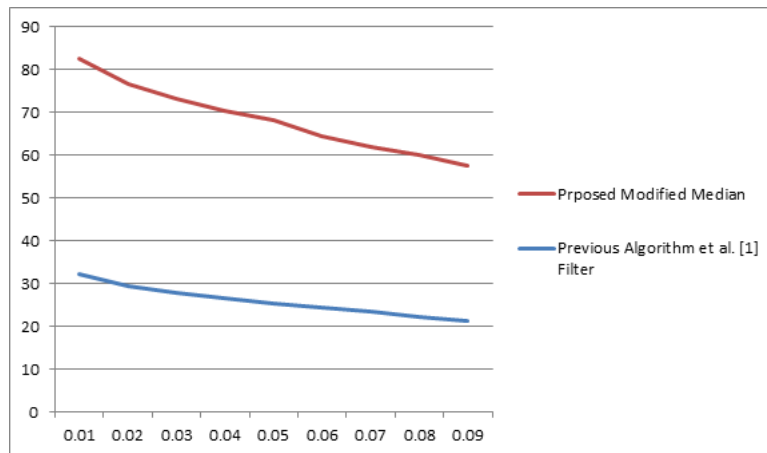


Figure 4: Bar Graph of the Previous Algorithm and Proposed Algorithm in Salt and Pepper Image

## VI. CONCLUSION

Impulsive noise being contaminated in some pixels based on probability densities. Basically Impulsive noises are basically two types- Salt & Pepper Noise (SPN) and Speckle Noise. In chapter we first try to distinguish between SPN and Speckle noise. Some previous schemes are most suitable to remove Speckle noise. Mostly performance of selective filtering scheme dependent on a impulse noise detector to decide where the pixel under study is noisy or not.

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