Computational Efficient Technique for Denoising of Salt and Pepper Noise

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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 minimization 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, Median filter, PSNR, MSE, denoising, impulse noise, mean, median, image processing,

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.[22]

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.The mode to getting and analyzing visual-data by computerized image preparing which is done by computers.. Initially, image as digital form can be represented as a two-dimensional f (l, m). The image f (l, m) whereas l and m are spatial co-ordinates and amplitude of 'f' at a pair of coordinates (l, m) is termed as the intensity of an image on this point in time. The images are mainly two types. They are Gray scale image and colour image. In Gray scale image, An image is a function I of two spatial coordinates of an image plane is a gray scale image. The image I(l, m) is located at the intensity of the image at the point (l, m)in the image plane. And another is Colour image. In this colour image, the image has the three functions that are R for red, G for green and B for blue. An image might be continuous by the reference to the l and m coordinates and is also occur in amplitude. The coordinates and the amplitude of an image are converted into the digital image to be digitized. Sampling is obtained by digitization of the coordinates values[21]. Quantization is obtained by the digitization of the amplitude values. The sampled image f(l, m) has M X N size where M represent no of rows and N represent no of columns[49]. Another illustration is that the origin of coordinate system at the point (r, c) = (1, 1). Hence, r is ranged from 1 to M and c is of from 1 to N in integer values. Moreover, the image processing toolbox employed another image coordinate convention termed as spatial coordinates, where columns is denoted by x and rows is denoted by y. In this array, each and every element is named as the image pixel, image element or picture element or pixel, pixel term is famous among all. Normally, digital image is to represent in the matlab matrix.normally, the terms M and N are stand for the number of rows and columns of a matrix respectively. Image processing is very essential for achieved the desired output from data. Figure 1.1 shows the classification of image processing techniques. Image enhancement can be done by so different techniques such as increase the contract and saturation by change the intensity of image pixels. If image are corrupted by noise than noise removal techniques have to use to enhancement the image quality.[52]

II. LITERATURE REVIEW

Arjun Singh Chauhan et al, In this paper they proposed an efficient method for removal of high as well as low density impulse noise. Salt and Pepper Noise is very common during transmission of images through a noisy channel or due to impairment in camera sensor module. For noise removal, methods have been proposed in literature, with two stage cascade various configuration. These methods, can remove low density impulse noise, are not suited for high density noise in terms of visible

performance their approach is based on novel extension over iterated conditional modes (ICM).
Ashutosh Dehuri et al. Noise is an inevitable part of real world images, so that efficient denoising is highly necessary, that leads to improve the performance. This makes the task of image denoising a great challenge for researchers. Denoising is a pre-processing task for the problems like identification, segmentation and classification. This paper deals with the filtering techniques using discrete cosine transform (DCT) which is a transform based filtering, median filtering, and bilateral filtering.
Madhulika Pandey et al In applications of signal processing such as medicine, communications and satellites, preprocessing is considered as a vital step which focuses on reduction or removal of the level of the noise contained in the image. The process of denoising helps in preserving the finer details and useful information. Medical images like MRI, CT and X-ray contain very fine details that need to be correct and free from noise so that the information and features of interests are not lost during the diagnosis. In this paper, various noise reduction techniques such as wavelet transform, Neural Network, PCA, ICA and mean and median filters over medical images has been discussed. In this paper we tried to highlight the strength and weakness of various noise removal techniques over processing of the medical images.
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.
Neela Chithirala et al, 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. Suman Shrestha, Noise is a major issue while transferring images through all kinds of electronic communication. One of the most common noise in electronic communication is an impulse noise which is caused by unstable voltage. In this paper, the comparison of known image denoising techniques is discussed and a new technique using the decision based approach has been used for the removal of impulse noise. All these methods can primarily preserve image details while suppressing impulsive noise. The principle of these techniques is at first introduced and then analysed with various simulation results using MATLAB. Most of the previously known techniques are applicable for the denoising of images corrupted with less noise density. L. Ramya and N. Awanish Kumar Shukla et al, This paper presents an approach to improve the performance of Directional Weighted Median (DWM)Filter based restoration of images corrupted with fluw'Valued impulse noise. The proposed approach involves minimum absolute difference criteria to distinguish among the edgeand non-edge pixels. The identified corrupted pixels are then replaced by weighted median or mean value computed within the local window employing the proposed decision criteria. Further, to filter the residual noise at high density corruption; the proposed approach converges in less than five iterations. Simulation results showan improvement in visual quality of restored images both in terms of noise filtering as well as preservation of edges and structural content. M.Jayamanmadharao et al They described 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. In this paper, a new hybrid filtering algorithm is presented for the removal of impulse noise from digital images. Here, they replace the impulse noise corrupted pixel by the median of the pixel scanned in four directions. 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.A James. et al., they have proposed image restoration for multiple copies: A GMM based technique. They have addressed the problem of utilizing multiple degraded observations of an image for better image restoration. They proposed an algorithm which utilizes the correlated information from all different observations to produce better reconstruction quality. Different experiments con- ducted to evaluate the performance demonstrates effectiveness of the algorithm in using correlation among multiple observations. Recovery of original images from degraded and noisy observations is considered an important task in image processing. 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 medianoperation 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]. Vikrant Bhateja et al Integration of decision based schemes with median filtering has been applied previously in numerous works to identify and process only the corrupted pixels during image denoising. However, these approaches are performance limited owing to their dependency upon selection of pre-defined thresholds as a decision measure. This paper presents a novel algorithm for performance improvement of decision median filter for suppression of salt and pepper noise in digital images. 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.R Lan et al ,they have proposed visual coherence metric for evaluation of color image restoration for assessing the quality of color image inpaintingdescribe that which takes into account some constraints and characteristics related to the specific objectives of inpainting approaches. The used characteristics are the visual coherence of the re- covered regions and the visual saliency describing the visual importance of the area. A series of psychophysical experiments have been conducted to evaluate the performance of the proposed image quality index.

III. DE-NOISING METHODS

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.[5,6] 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[21].There are so many filters are used to remove noisr from images but median filter is mostly used to remove the salt and pepper noise from images. Median filter is an easy and simple implementation of non-linear filter for noise removal. In this median filter technique, the targeted noisy pixels are replaced by median value of its neighbours. The number of neighbours depends upon the window size of filter. The median value is simply described as the mid value in a sorted sequence. Median (P) = Med {Pi} = Pi(k +1)/2, k is odd

Median(P) = ½[Pi(k/2)+ Pi(k/2)+1], k is even P1, P2, P3 ……Pk is the sequence of neighbour pixels. All pixels in the image has to be arranged in either ascending or descending order, before applying filtering. After performing sorting, the resulting image pixel sequence will be Pi1Pi2Pi3.....Pik, .k is usually odd. 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. 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.[4] 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].

IV.METHODOLOGY OF PROPOSED WORK

In this section proposed method is discussed identifying the noise in the image and then de-noising it using double threshold median filter as well as preserving edges of image.The window of size 3x3 chooses for noise detection and noise removal. The window contains total 9 elements which are as follows: Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9. First step selects the maximum, minimum and median values of columns and rows. Second step stores these values and selects minimum threshold, maximum threshold and final median value[8]. Third step use threshold values for noise detection and final median value for noise removal. We are parallel calculating the threshold values and median value. So there is no need to perform noise detection and noise removal separately.

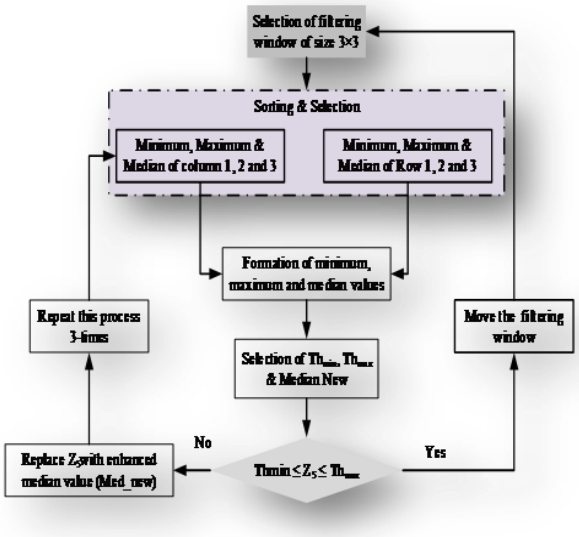


Figure 2: Flow chart of proposed method for median filtering

IV. SIMULATION RESULTS AND DISCUSSION

Simulation parameters are PSNR and MSE are used to compare the performance of our proposed method with exiting method..The PSNR value approaches as high as possible the MSE approaches to zero; these results show that a higher PSNR value provides a better image quality. At the other end of the parameter, a small change in the PSNR indicates high numerical differences between image qualities. PSNR is usually represents in terms of the logarithmic decibel scale.

$$PSNR = 10log_{10}\frac{(255)^2}{MSE} \quad \text{.....(1)}$$

Where MSE (Mean square error), is

$$MSE = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}[z(i,j)-A(i,j)]^2}{m\times n} \quad \text{..... (2)}$$

With respect to the noise-free original image A.

SIMULATION TOOL:

MATLAB is a high level technical computing language and algorithm development tool that can be used in several applications such as data visualization/analysis, numerical analysis, signal processing, control design, etc. Using the MATLAB software, solution can be achieved faster than traditional programming languages, such as C, C++. Add on toolboxes are a collections of special purpose MATLAB functions that are available separately.

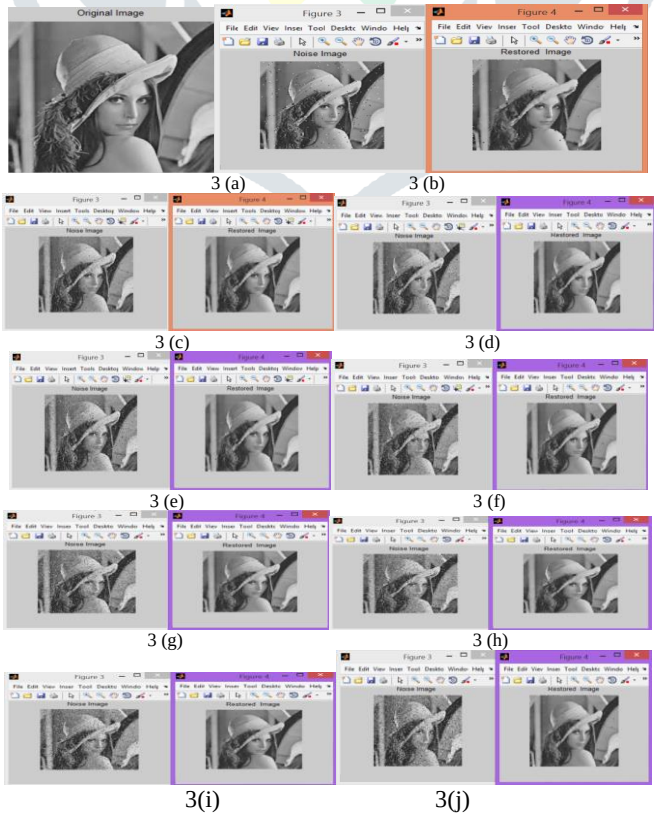
RESULT ANALYSIS:

Any handling connected to a picture may bring about a critical loss of data or quality. The PSNR is most normally utilized as a measure of nature of remaking of misfortune pressure codecs e.g., for picture pressure. The flag for this situation is the first information, and the clamor is the qualities presented by incautious commotion. When comparing denoising results it is used as an approximation to human visibility of reconstruction quality, therefore in some cases one denoising results may appear to be closer to the original than another methods, even though it has a lower PSNR and a higher PSNR would normally indicate that the denoising method is of higher quality. We have to be extremely careful with the range of results; it is only comparably valid when it is used to compare results from the different denoising algorithms and same content.

The PSNR value approaches as high as possible the MSE approaches to zero; these results show that a higher PSNR value provides a better image quality. This algorithm is mainly used for high density impulse noise because many algorithms give good results at low noise densities but very poor results at high noise densities. Using this method, we have performed image de-noising on different images like Lena Image,Boat image , Brain image of size 256x256 and simulate their results on MATLAB. For different high noise density levels that are 10%-90%, the resultant peak signal to noise ratio (PSNR) are also mentioned in tables, and we made a comparative analysis based on this PSNR of de-noised image.

Result for Lena Image

Clearly that the figure 3 (a) show the original image of Lena image. Figure 3 (b) shows the 0.1 salt noise and restored image, Figure 3 (c) shows the 0.2 salt noise and restored image, Figure 3 (d) shows the 0.3 salt noise and restored image, Figure 3 (e) shows the 0.4 salt noise and restored image, Figure 3 (f) shows the 0.5 salt noise and restored image, Figure 3 (g) shows the 0.6 salt noise and restored image, Figure 3 (h) shows the 0.7 salt noise and restored image, Figure 3 (i) shows the 0.8 salt noise and restored image and Figure 3 (j) shows the 0.9 salt noise and restored image of the Lena image. From the visual outputs, it is very clear that image de-noised by proposed method has good quality.



3 (a) 3 (b)

3 (c) 3 (d)

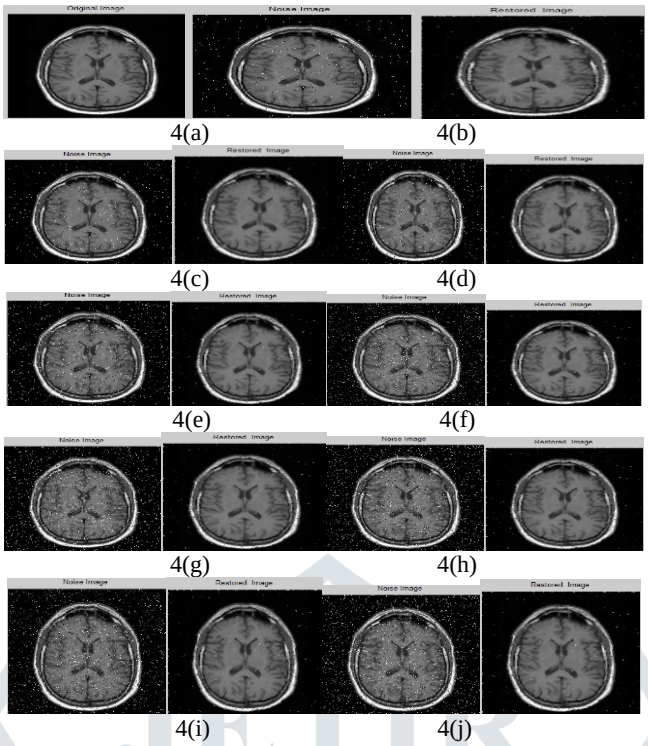
3 (e) 3 (f)

3 (g) 3 (h)

3(i) 3(j)

Figure 3 (a) to (j) show the original image of Lena with noise density 01 to 0.9 and restored images.

Similarly Result for Brain Image is shown below in figure 4 From the visual outputs, it is very clear that image de-noised by proposed method has good quality.



4(a) 4(b)

4(c) 4(d)

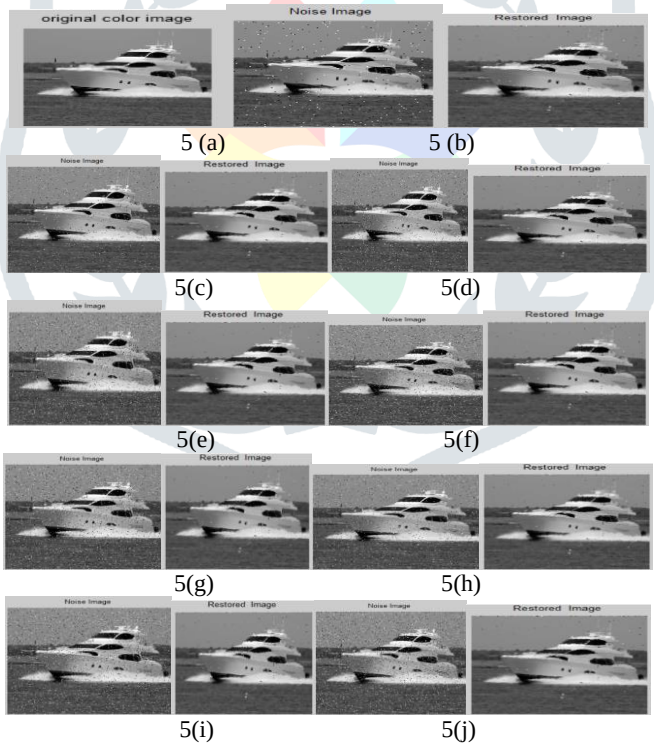
4(e) 4(f)

4(g) 4(h)

4(i) 4(j)

Figure 4 (a) to (j) show the original image of brain with noise density 01 to 0.9 and restored images

Also Result for Boat Image shown in figure 5. From the visual outputs, it is very clear that image de-noised by proposed method has good quality.



5 (a) 5 (b)

5(c) 5(d)

5(e) 5(f)

5(g) 5(h)

5(i) 5(j)

Figure 5 (a) to (j) show the original image of Boat with noise density 01 to 0.9 and restored images

COMPARISION RESULT FOR PREVIOUS AND PROPOSED FILTER

The simulation results 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. The graphical illustration of the performance of different noise density discussed in this research work in term of mean square error (MSE) and peak signal to noise ratio (PSNR) for Lena Image shown in figure 7. From the graphical representation it can be inferred that the proposed modified median filter gives the 29.07% increase peak signal to noise ratio (PSNR) for previous algorithm.

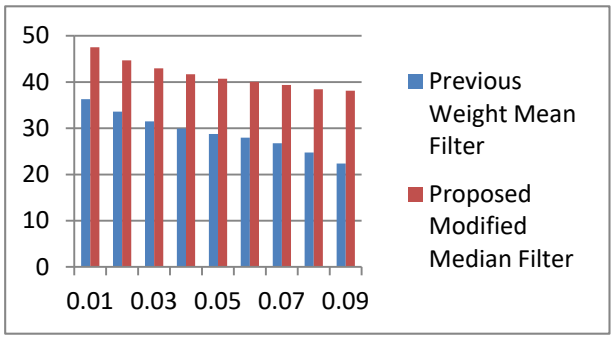


Figure 7 Noise Density V/S PSNR(DB) for Lena Image

The results in the figure 7 clearly show that the PSNR of different method is much better that the proposed modified median filter gives the 38.96% increase peak signal to noise ratio (PSNR) for previous algorithm.

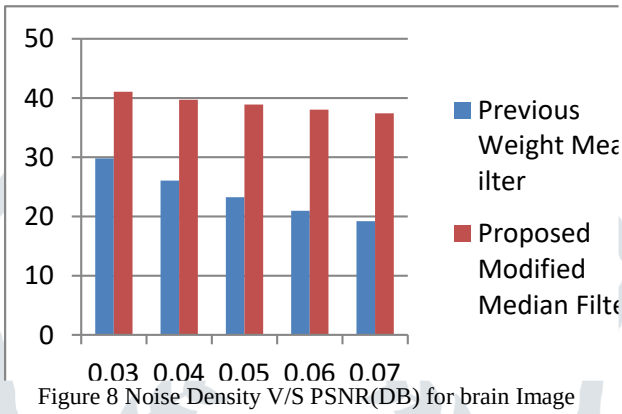


Figure 8 Noise Density V/S PSNR(DB) for brain Image

The results in the figure 8 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. The proposed modified median filter gives the 38.96% increase peak signal to noise ratio (PSNR) for previous algorithm. Figure 9, shows PSNR and MSE value for boat image, proposed modified median filter gives the 23.97% increase peak signal to noise ratio (PSNR) for previous algorithm.

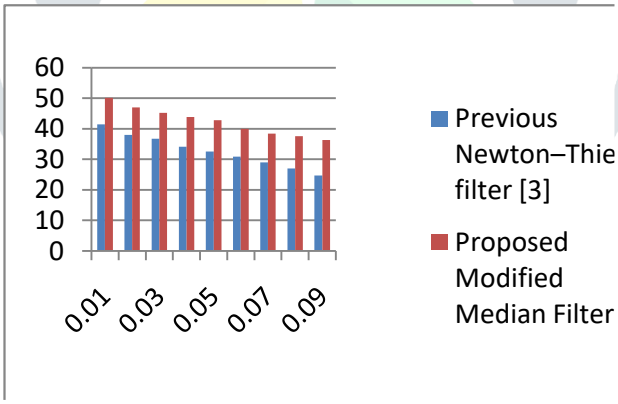


Figure 9 Noise Density V/S PSNR(DB) for Boat Image

VI. 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. The proposed filter has proved that it is very efficient for random valued impulse noise because practically noise is not uniform over the channel. It delivers great peak signal to noise ratio (PSNR) and little Mean Square Error (MSE) for profoundly debased pictures, particularly for over half clamor thickness. Salt and pepper noise or impulse noise can occur due to a random bit error in a communication channel. This high density noise can be removed with the help of median filter which is also useful in preserving edges in an image while reducing random noise. The proposed method improved the quality of de-noised image especially for random valued impulse noise. PSNR & MSE has been calculated for the performance analysis and result shows excellent variations in the result. Implementation modified median filter are consumed 29.07% increase peak signal to noise ratio (PSNR) for Lena image, 38.96% increase peak signal to noise ratio (PSNR)for Brain image, 23.97% increase peak signal to noise ratio (PSNR) for Boat image Based on the results of the investigations presented in this work, some suggestions for the future work in the field of Image restoration are summarized. This method can have great application in the field of

communication, because large amount of noise introduced during the transmission of data. The day to day emerging technology requires more and more revolution and evolution in the image processing field. The proposed denoising technique can provide a good platform for further research work in this respect.

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