Decision Based Algorithm for the Removal of High Density Salt and Pepper Noise in Images and Videos

S.Dinesh Krishnan
Assistant Professor, Computer Science Engineering, RVS Technical Campus, Coimbatore, India.

R.Manoj Kumar
PG Scholar, Computer Science Engineering, RVS Technical Campus, Coimbatore, India.

Abstract – A Decision based algorithm for high-density salt and pepper noise removal in images and videos are proposed. The existing non-linear filter like Standard Median Filter, Adaptive Median Filter shows better results at low and medium noise densities. At high noise densities, their performance is poor. Decision based algorithm to remove high-density salt and pepper noise using sheer sorting algorithm is proposed. Results of the algorithm is compared with various existing algorithms and it is proved that the new method has better visual appearance and quantitative measures at higher noise densities as high as 90%. The proposed system works efficient with both Grey scale and coloured images. Divide the image into 3*3 blocks but the image should be in 255*255. By using shear sorting algorithm we will arrange in ascending order and remove the noise by getting the values of 0 and 255. A graph has been displayed to show the result when the noise has been added to image of 10 to 90% and removing the noise. The second phase has been tried the same with Video files which have been converted as frames. The noises at various densities have been applied to the frames. The PSNR and MSE values have been calculated and displayed in graph. Both image and video files have been demonstrated and the quality measures plotted.

Index Terms – Salt and pepper noise, Filters, Noise, Decision based algorithm, Shear sort algorithm.

1. INTRODUCTION

Salt and pepper noise is a form of noise typically seen on images. It represents itself as randomly occurring white and black pixels. An effective noise reduction method for this type of noise involves the usage of a median filter, morphological filter or a contra harmonic mean filter. Salt and pepper noise creeps into images in situations where quick transients, such as faulty switching, take place. Fat-tail distributed or "impulsive" noise is sometimes called salt-and-pepper noise or spike noise. An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions. This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc. This can be eliminated in large part by using dark frame subtraction and by interpolating around dark/bright pixels. Use linear filtering to remove certain types of noise. Certain filters, such as averaging or Gaussian filters, are appropriate for this purpose.

Use linear filtering to remove certain types of noise. Certain filters, such as averaging or Gaussian filters, are appropriate for this purpose. For example, an averaging filter is useful for removing grain noise from a photograph. Median filtering is similar to using an averaging filter, in that each output pixel is set to an average of the pixel values in the neighborhood of the corresponding input pixel. However, with median filtering, the value of an output pixel is determined by the median of the neighborhood pixels, rather than the mean.

This salt and pepper noise produces lots of trouble to the images by spreading the black and white dots on the image or video file. Salt and pepper noise is also called as Impulsive noise. Impulsive noise consists of relatively short duration “on/off” noise pulses, caused by a variety of sources, such as switching noise, adverse channel environments in a communication system, dropouts or surface degradation of audio recordings, clicks from computer keyboards. An impulsive noise filter can be used for enhancing the quality and intelligibility of noisy signals, and for achieving robustness in pattern recognition and adaptive control systems. We need a better system to avoid this salt and pepper noise in the images or videos.

2. RELATED WORK

ShivpratapPandey [9] presented a new Modified Progressive Switching Median filtering algorithm is presented for the removal of salt and pepper noise from corrupted images. It sets a limit on the number of good pixel used in determine median and mean value and substitute to impulse pixel with the summation of its mean value and median value which is divide by 2.02, after that pass through Gaussian filter. This scheme can remove salt and pepper noise with a noise level as high as 90%. Experimental result shows that the proposed filter is superior over the traditional filter in maintaining higher PSNR (Peak Signal to Noise Ratio).

LovepreetKaur [4] has presented about noise in images has become one of the significant concerns in digital image processing. Many digital image based techniques produce inaccurate results when noise is presented in the digital images. Many researchers have proposed new and modified techniques

so far to reduce or remove noise from images. Different kind of enhancement in the filters has been proposed so far. But most of filters put artefacts while doing their work. Many filters fail when noise density in the images is very high. Some filters results poor for edges. This paper has proposed a new improved NSA based switching median filter [10] which has the capability to decrease the high density of the noise from images and also outperforms over others when input image is noise free. The proposed method has also ability to preserves the edges by using the gradient based smoothing. The proposed technique has been designed and implemented in MATLAB tool using image processing toolbox. Different kind of the digital images has been taken for experimental purpose. Comparative analysis has shown that the proposed algorithm is quite effective over the available techniques.

Ramanaiah [5] on the other hand, Noise hides the important details of images. To enhance the image qualities, we have to remove noises from the images without loss of any image information. Image denoising is one such powerful methodology which is deployed to remove the noise through the manipulation of the image data to produce very high quality images. There are different types of noises which corrupt the images. These noises are appeared on images in different ways: at the time of acquisition due to noisy sensors, due to faulty scanner or due to faulty digital camera, due to transmission channel errors, due to corrupted storage media. Impulse noise in image is present due to [3] bit errors in transmission or induced during the signal acquisition stage. There are two types of impulse noise, like salt and pepper noise and random valued noise. Salt and pepper noise can corrupt the images where the corrupted pixel takes either maximum or minimum grey level. [1] Several non-linear filters have been established as reliable method to remove the salt and pepper noise without damaging the edge details, each having their own merits and demerits.

Noise deletion is a significant issue in the field of image processing. In this paper switching threshold algorithm for the elimination of high density salt and pepper noise is proposed. It is implemented in two steps; firstly switching threshold is applied to the whole image to detect the pixels as corrupted/uncorrupted. Secondly, new pixel value is anticipated only for the corrupted pixels. Kaisar[2] presented the algorithm use an adaptive length window. The existing methods are Arithmetic Mean Filtering (AMF) technique [2], Geometric Mean Filtering (GMF) technique, Harmonic Mean Filtering (HMF) technique. The proposed algorithm automatically switches the window size as per the noise occurrence. Performance of algorithm is evaluated in terms of Mean square Error, Peak Signal to Noise Ratio, Image Enhancement Factor, and processing time and evaluated with other filtering techniques. Extensive simulation shows that proposed algorithm removes the noise even though noise level as high as 50% and produces better results than that of existing filtering techniques.

3. IMAGE PROCESSING

In engineering and computer science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging. Digital image processing is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems.

3.1 Image and Video Noise Reduction

In image processing, the high sensitivity image quality of a given camera may depend greatly on the quality of the algorithm used for noise reduction. Since noise levels increase as ISO sensitivity is increased, most camera manufacturers increase the noise reduction aggressiveness automatically at higher sensitivities.

Removing noise: Digital images are prone to a variety of types of noise. Noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene. There are several ways that noise can be introduced into an image, depending on how the image is created. If the image is scanned from a photograph made on film, the film grain is a source of noise.

Noise can also be the result of damage to the film, or be introduced by the scanner itself. If the image is acquired directly in a digital format, the mechanism for gathering the data (such as a CCD detector) can introduce noise. Electronic transmission of image data can introduce noise. To simulate the effects of some of the problems listed above, the toolbox provides the imnoise function, which you can use to add various types of noise to an image. The examples in this section use this function.

3.2 Noise in Videos

Noise, in analog video and television, is a random dot pattern of static displayed when no transmission signal is obtained by the antenna receiver of television set and other display devices. The random pattern superimposed on the picture, visible as a

random flicker of "dots" or "snow", is the result of electronic noise and radiated electromagnetic noise accidentally picked up by the antenna. This effect is most commonly seen with analog TV sets or blank VHS tapes.There are many sources of electromagnetic noise which cause the characteristic display patterns of static. Atmospheric sources of noise are the most ubiquitous, and include electromagnetic signals prompted by cosmic microwave background radiation, or more localized radio wave noise from nearby electronic devices.

3.3 Removal of Video Noise

Video de-noising is the process of removing noise from a video signal. There are many ways we can reduce the noise in the video files. The most common method used is spatial video de-noising methods, where image noise reduction is applied to frames individually. We have converted the video files to frames using total video converter. This can be done using video converting software. The video files are now in the form of frames. We apply the decision based algorithm on the frames as we applied on images earlier. We have to apply noise in various density and we have to calculate the quality measures.

4. THE PROPOSED METHOD

A Decision Based Algorithm has been proposed in this paper.A 2-D window ‘S xy’ of size 3x3 is selected. The pixel values in the window are sorted in ascending order, and stored in a 1-D array. If the pixel value in the array is either '0' or ‘255’, the corresponding pixel values are trimmed (eliminated), and the median of remaining values is calculated. The pixel being processed is replaced by the median value calculated. Decision based algorithm is to remove high-density salt and pepper noise using modified sheer sorting method is proposed. The new algorithm has lower computation time when compared to other standard algorithms. Digital images are often corrupted by impulse noise, due to faulty camera sensors, transmission of images over faulty channels. Impulse noise is of two types, salt and pepper noise and random valued impulse noise. The intensity of salt and pepper noise always takes relatively high or low gray level. Filtering the corrupted digital image by preserving its details is very important part of image processing. Various nonlinear filtering techniques have been formulated. Standard median filters (SMF) removed salt and pepper noise effectively by preserving the edges but flatters at high noise densities. An adaptive median filter eliminated the above drawback, but owing to its increasing window size lead to blurring of images. But we need decision based algorithm to overcome this salt and pepper noise.The proposed system works efficient with both Grey scale and coloured images. We will divide the image into 3*3 blocks but the image should be in 255*255. By using shear sorting algorithm we will arrange in ascending order and remove the noise by getting the values of 0 and 255. A graph has been displayed to show the result when the noise has been added to image of 10 to 90% and removing the noise. Again re-arrange the divide blocks into original input Image. If we give any salt and pepper noise image, it will removed by calculating the above method but noise alone we will not add in above method and hence noise will be removed. We will calculate PSNR, MSE and Quality value to both noise image and noise added image.The proposed system has been working fine with both images and videos. This proposed method gives out the greater way of removing the salt and pepper noise in videos and images. In this paper DBA method has been worked along with shear sorting algorithm. The following figures explain the proposed system for removal of salt and pepper noise in both grey scale and color images.

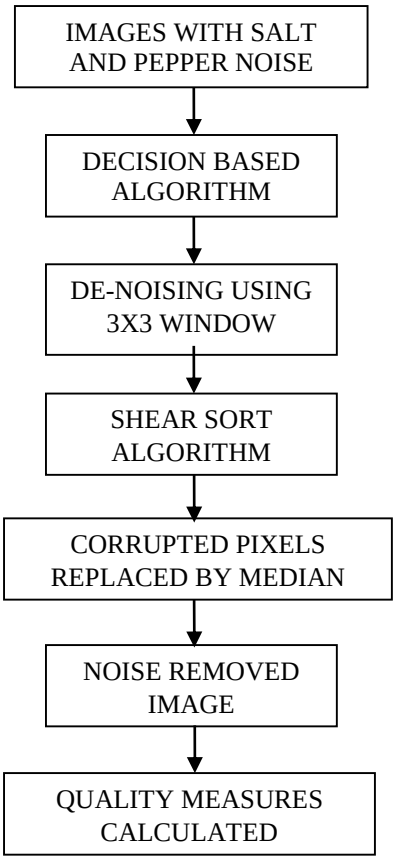


Fig. 1Block Diagram-Proposed Method for Removal of Noise in Image.

This Fig1 has been referring the sale and pepper noise removal in the images. In this paper, the images applied in both grey scale and color images. The proposed system works fine with both grey scale and color images and it reduces the noise even in very high density noise levels.

The following block diagram explains the proposed system for removal noise in video files. In video files, the video has to be converted as a set of frames to be processed. The frames have

been extracted from the video. The coding has been written to get the frames from the given video file. The impulse noise has been added in various ranges so that we can check the PSNR and MSE values in different densities. When converting video to frames, we have selected ten frames to be extracted from the video file. These ten frames are going to be processed against various noise densities. The number of frames have been selected by using this function f=xyloObj.Numberofframes.

The video frames have been given to test with various noise density levels up to ninety percentage of the noise given to video file. The various noise densities will be displayed to identify how effective they corrupt or spoil the clarity of the given video file. The frames are given with noise density. The noise has been added as we get the input of how many percentage of noise should be included and processed. We can give various density levels to add noise to the given frames. After adding noise the DBA will be processed so that the de-noising is done by the same method that we followed in image noise removal. The module expresses the removal of noise through decision based algorithm. The shear sorting algorithm is used. The frames will be taken and treated as image and 3x3 window has been taken and noise will be removed by the replacing the salt and pepper noised pixels with the median values.The frames now treated as images and the noise has been removed. The frames will be put together as video to see how effective the noise has been reduced.

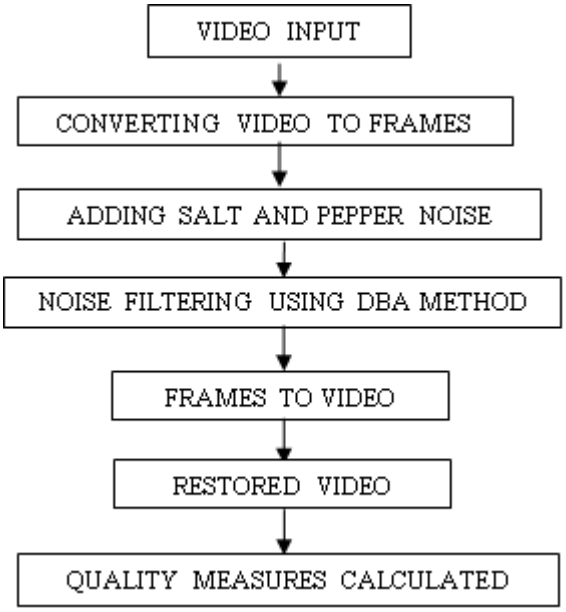


Fig. 2 Block Diagram-Proposed Method for Removal of Noise in Video

The video frames have been given to test with various noise density levels up to ninety percentage of the noise given to video file. The various noise densities will be displayed to identify how effective they corrupt or spoil the clarity of the given video file. The frames are given with noise density. The noise has been added as we get the input of how many percentage of noise should be included and processed. We can give various density levels to add noise to the given frames. After adding noise the DBA will be processed so that the de-noising is done by the same method that we followed in image noise removal. The module expresses the removal of noise through decision based algorithm. The shear sorting algorithm is used. The frames will be taken and treated as image and 3x3 window has been taken and noise will be removed by the replacing the salt and pepper noised pixels with the median values.The frames now treated as images and the noise has been removed. The frames will be put together as video to see how effective the noise has been reduced.

4.1 Noise Added in Images at Various Level

The proposed system works efficient with both Gray scale and coloured images. We will divide the image into 3*3 blocks.The sorting is carries in the next module.C = mat2cell A,dim1Dist,...,dimNDist) divides array A into smaller arrays within cell array C. Vectors dim1Dist,...dimNDist specify how to divide the rows, columns, and (when applicable) higher dimensions of A.

C = mat2cell (A,rowDist) divides array A into an n-by-1 cell array C, wheren == numel (rowDist).nois=imnoise(im,'salt& pper',0.1*de). I have used this function to add noise in various density levels to the image.

4.2 Shear Sort Algorithm

The shear sorting algorithm has been used throughout this paper.

Output: the array sorted in snake-like order

Method:

1. Repeatlog (n) times. Sort the rows (in alternating direction);

   Sort the columns;

2. Sort the rows (in the desired direction);

Sorting the rows in alternating direction means that even rows are sorted from left to right and odd rows from right to left. If a comparator network sorts every sequence of 0's and 1's, then it sorts every sequence of arbitrary values. Without loss of generality, we may therefore restrict the proof to input a sequence consisting of 0’s and 1’s.A row is called clean, if it consists of 0's only or 1's only, otherwise it is called dirty. A maximal connected region along the sorting order that starts with a 1 and ends with a 0 is called an unsorted zone. After sorting the rows in the first step, there are $n/2$ rows that are sorted from left to right and $n/2$ rows that are sorted from right to left. When sorting the columns, every two of these rows are combined to at least one clean row. Thus, after the first iteration

the array consist of some clean 0-rows, some clean 1-rows and an unsorted zone in between consisting of at most *n*/2 rows. In the second iteration, every two rows of the unsorted zone are again combined to at least one clean row. Thus, after the second iteration the unsorted zone consists of at most *n*/4 rows, and so on. After log (*n*) steps, there is at most one dirty row. In the additional last step this row is sorted, and the whole array is sorted. In the following simulation of shear sort a 32 ×32-array of 0's and 1's is sorted in row-major order. Sorting a row of length *n* with odd-even transposition sort takes *n* steps. Since the algorithm performs log (*n*) iterations, it requires *n*log (*n*) steps for row sorting plus *n* steps for the additional row sorting operation. In each iteration, the height of the unsorted zone decreases by a factor of 2. This means that the columns contain an unsorted zone of decreasing length. Sorting a column that contains an unsorted zone of length *k* takes *k* steps of odd-even transposition sort.After the shear sort algorithm module, we get an array sorted. The salt and pepper noise pixel will be trimmed. Noisy pixels have been replaced with median of the window.A 2-D window 'S xy' of size 3x3 is selected. The pixel values in the window are sorted in ascending order, and stored in a 1-D array .If the pixel value in the array is either '0' or '255', the corresponding pixel values are trimmed (eliminated), and the median of remaining values is calculated.

4.3PSNR and MSE Values Calculated

PSNR value has been plotted in graph.MSE Value is calculated.Quality measures have been compared.The phrase peak signal-to-noise ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmicdecibel scale.The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs it is used as an approximation to human perception of reconstruction quality, therefore in some cases one reconstruction may appear to be closer to the original than another, even though it has a lower PSNR (a higher PSNR would normally indicate that the reconstruction is of higher quality). One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content. It is most easily defined via the mean squared error (MSE) which for two m×n monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as:

$$MSE = \frac{1}{m\,n}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j)-K(i,j)]^2$$

The PSNR value has been defined as:

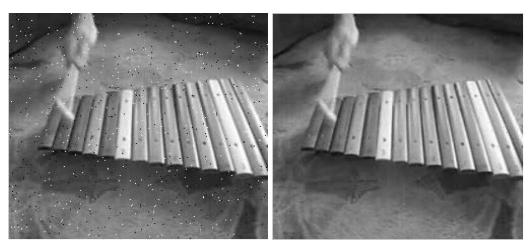
$$\begin{aligned} PSNR &= 10\cdot\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20\cdot\log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \\ &= 20\cdot\log_{10}(MAX_I) - 10\cdot\log_{10}(MSE) \end{aligned}$$

(A) Original image (B) Video input

255 is the maximum grey level possible in case of 8-bit image format.Here, MAX_I is the maximum possible pixel value of the image. When the pixels are represented using 8 bits per sample, this is 255.More generally, when samples are represented using linear PCM with B bits per sample, MAX_I is 2^B-1. For colour images with three RGB values per pixel, the definition of PSNR is the same except the MSE is the sum over all squared value differences divided by image size and by three.

Alternately, for colour images the image is converted to a different colour space and PSNR is reported against each channel of that colour space.

(B) 90% Noise added (C) Noise removed



(B) Noise added (C) Noise removed

Fig. 3 Results for Proposed method

5. IMPLEMENTATION RESULTS AND ANALYSIS

The algorithm is implemented using Matlab with processor above 500 MHz, 2GB RAM, 250GB hard disk and Windows 7(32-bit) operating systems. Figures 4 shows the results of

image encryption method based on genetic operator using Lena as original image.

The following figure explains the results of the Decision Based Algorithm applied after adding the salt and pepper noise to the images and videos files. This image has been tested with both grey scale and colour images. The video files have been taken as input and the frames have been extracted from the video files and the impulsive noise has been added in various percentages.

5.1 Tablature representation

There are few similarities between original images/video and their de-noised image and videos.

Table 1 PSNR for Image Lena

Noise	**PSNR for image 'Lena'**			
	SMF	**AMF**	**Existing System**	**DBA**
10%	22.75	29.48	38.43	45.2001
20%	18.75	28.30	37.36	41.3108
30%	15.30	27.10	35.92	39.8664
40%	13.18	25.55	34.12	39.2460
50%	11.82	24.04	32.21	37.7585
60%	11.00	21.07	30.43	36.8635
70%	10.72	16.10	28.62	35.7407
80%	9.08	11.60	26.23	35.6405
90%	8.25	8.02	23.94	34.8168

Table 2Quality Values for Grey image Lena

Noise	PSNR	MSE
10%	45.2001	1.9637
20%	41.3108	4.8084
30%	39.8664	6.7056
40%	39.2460	7.7353
50%	37.7585	10.8951
60%	36.8635	13.3884
70%	35.7407	17.3385
80%	35.6405	17.7434
90%	34.8168	21.4486

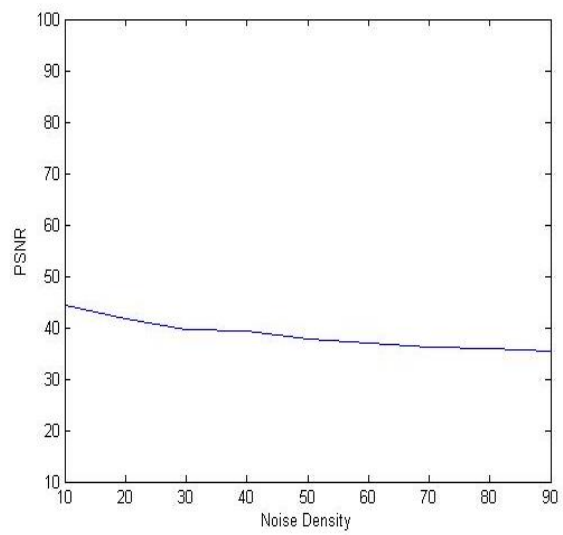
Table 3Quality Values for colour image Lena

Noise	PSNR	MSE
10%	39.9567	6.5676
20%	36.9400	13.1548
30%	34.9087	20.9994
40%	33.7736	27.2722
50%	32.9587	32.9009
60%	32.4850	36.6925
70%	31.5314	45.7030
80%	31.0218	51.3922
90%	30.5700	57.0269

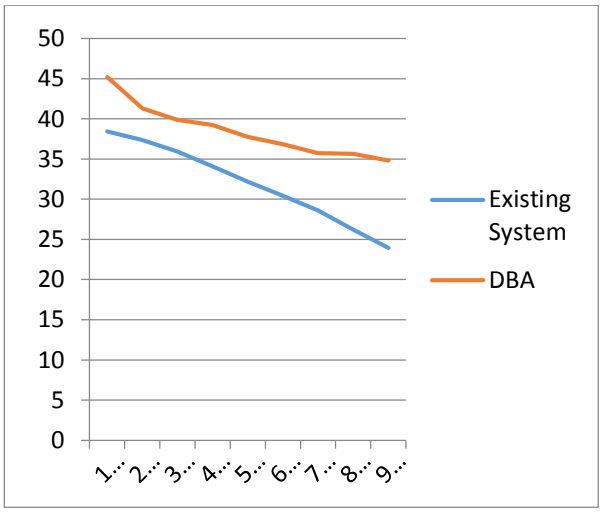
Table 4PSNR Values for video frames

Noise	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5
10%	33.019	32.82	33.993	33.087	32.968
20%	32.84	32.655	32.070	32.578	32.899
30%	32.64	32.18	32.5620	32.843	32.177
40%	32.35	32.38	32.33	32.215	32.165
50%	31.9	32.04	32.28	32.56	32.20
60%	32.04	31.7	31.9	31.78	31.9
70%	31.87	31.99	32.1	32.1	31.82
80%	31.4	31.3	31.71	31.41	31.89
90%	31.09	31.6	31.4	31.1	31.2

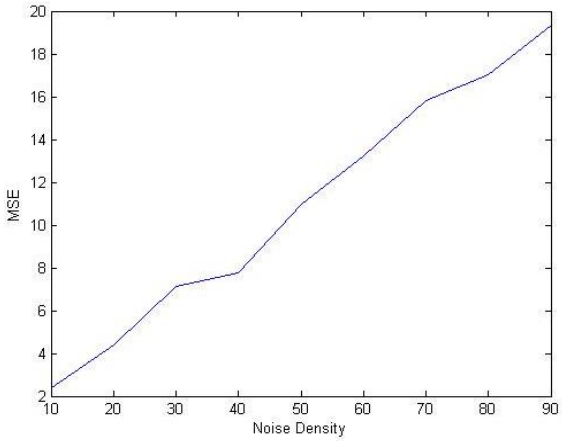
5.2 Graphical representation



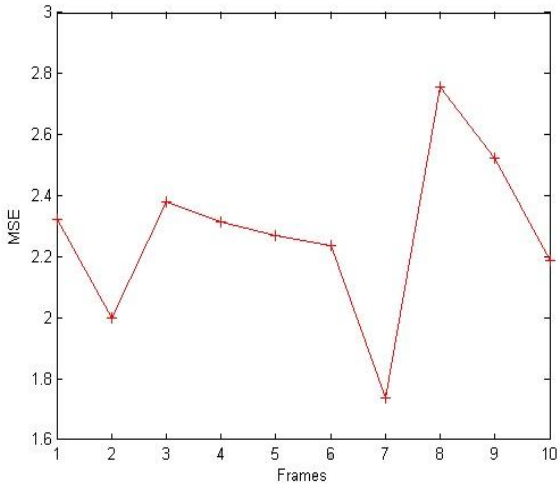
PSNR graphical representation



(A) Existing system Vs. Proposed Values



(B) MSE representation



(C) MSE Values for Video

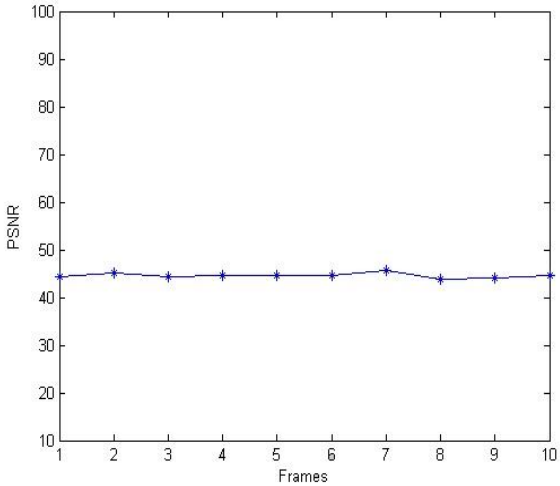


Fig. 4Graphical representation for images and videos in proposed method

6. CONCLUSION

In this paper, an efficient non-linear algorithm to remove high-density salt and pepper noise is proposed. The sheer sorting algorithm has been used in both image and noise removal. This increases the efficiency of the system. The approach removes noise even at higher noise densities up to 90% of the noise density and it preserves the edges and fine details. The quality measures have been compared with the existing system and the results are better in this proposed system.

With the help of decision based algorithm, the noise adding and removal has been performed and the quality measures have been shown in the graph. Thispaper has been working on the enhancements to achieve the noise removal in video files. The idea is to split the video files into frames andgo ahead with the DBA approach. Tried and enhanced the system for video files and calculated the quality measures like PSNR and MSE and the results were good. The noised and video noised outputs are calculated and the values have been displayed.

This paper has given the opportunity to the researchers and engineers to test and improvise it to the next level. The enhancement can be smoothing kind of techniques in image processing. High-density salt and pepper noise removal from video can be enhanced and extended to the various levels like video enhancements in colour videos, video segmentation techniques. The future enhancement can be extended to make an effort to achieve the edge detection and smoothing techniques to the colour video files. The extension would be appreciated with both grey scale and colour image and video smoothing techniques to remove salt and pepper noises in the colour videos.Thus the effective decision based algorithm has been used and yielded better results than the existing system. High-density salt and pepper noise removed from given image and video file.

REFERENCES

[1]. H. Hwang and R. A. Hadded, "Adaptive median filter: New algorithms and results," IEEE Trans. Image Process., vol. 4, no. 4, pp. 499–502, Apr. 1995.

[2]. Kaisar S., Md. SakibRijwanJubayer Al Mahmud Muhammad ―Salt and Pepper Noise Detection and removal by Tolerance based Selective Arithmetic Mean Filtering Technique for image restoration‖ in IJCSNS International Journal of Computer Science and Network Security, VOL.8 No.6pp 271-278, June 2008.

[3]. K. K. V. Toh, H. Ibrahim, and M. N. Mahyuddin, ―Salt-and-pepper noise detection and reduction using fuzzy switching median filter, ‖IEEE Trans.Consumer Electron., vol. 54, no. 4, pp. 1956–1961, Nov. 2008.

[4]. LovepreetKaur, Spardha- Removal of High Density Salt and Pepper Noise through Hybrid of Negative Selection Algorithm and Median Filter. International Journal of Computer Applications (0975 – 8887) Volume 107 – No 15, December 2014.

[5]. Ramanaiah., Sathish Kumar – Removal of Of High Density Salt and Pepper Noise in Images and Videos Using Denoising Methods

[6]. Rama S., tulasiP.Shiva Prasad ―A new efficient algorithm for removing of high density salt and pepper noise through modified median filter for video restoration.

[7]. R.H.Chan, C.-W.Ho and M.Nikolova. Salt and pepper noise removal by median type noise detectors and detail preserving regularization. IEEE Trans. Image Processing, Vol.14, No.10, pp.1479-1485, Oct 2005.

[8]. S.Manikandan, O.UmaMaheswari, D.Ebenezer, "An Adaptive Recursive Weighted Median Filter with Improved Performance in Impulsive Noisy Environment", WSEAS Transactions on Electronics, Issue 3, Vol.1, July 2004.

[9]. ShivpratapPandey., Md. Rashid Ansari., RupaliKushwaha - Removal of Salt and Pepper Noise through Modified PSM Filter International Journal of Computer Applications (0975 – 8887) Volume 74– No.1, July 2013.

[10]. Soon Ting Boo, Haidi Ibrahim, Member, IEEE and Kenny Kal Vin Toh, Student Member, IEEE, ―An Improved Progressive Switching Median Filter‖, IEEE International Conference on Future Computer and Communication,2009.

[11]. T.A.Nodes and N.C.Gallagher, "Median Filters: Some Modifications and their properties," IEEE Trans. Acoust., Speech and Signal Processing, vol. ASSP-30, pp.739-746, April 1987.