ISSN: 2321-8169
6820 - 6828

A Survey of Non-Linear Filtering Techniques for Image Noise Removal

[1]Ms. Mrunali P. Mahajan
(ME, Student)
[1]Dept of Electronics Engineering,
SSVPS's B.S. Deore College of Engg,NMU Dhule
mahajan.mrunali@gmail.com

[2] Prof. Sanjeev N Jain
(Professor)
Dept of Electronics Engineering,
SSVPS's BS Deore College of Engg,NMU Dhule
Sanjeev_n_jain@yahoo.com

Abstract: Image is captured or noninheritable by any image capturing device like camera or scanner and then it is stored in the mass storage of the computer system. In many of these applications the existence of impulsive noise among the noninheritable pictures is one altogether common problem. This noise is characterized by spots on the image and is usually related to the innate image because of errors in image sensors and information transmission. Now-a-days there are numerous strategies that are offered to remove noise from digital images. Most of the novel methodology includes 2 stages: the primary stage is to find the noise within the image and the second stage is to eliminate the noise from the image. This paper explores the varied novel methods for the removal of noise from the digital images. The distinctive feature of the all the described filters is that offers well line, edge and detail preservation performance while, at the constant time, effectively removing noise from the input image. In later section, we present a short introduction for various strategies for noise reduction in digital images.

Keywords: *D*ecision based median filter, negative selection algorithm, and salt and pepper noise, MSE, PSNR, IEF.

*****

I. INTRODUCTION

Digital image processing is one of most useful technique for computer algorithms to perform image processing on digital images [1]. A digital image is consist of a finite number of elements called pixels, every of that includes an explicit location and value. Image is captured or noninheritable by any image capturing device like camera or scanner and then it is stored in the mass storage of the computer system. Then it is processed exploitation the image processing/editing tool like MATLAB, photo-shop etc. so displayed on the displaying device and conjointly transmitted to the owner needed party. The image is subjected to many kinds of distortion during the stages that it might pass through such as such as storing, processing, compressing and transmitting etc. During transfer noise may get added along the actual information. Noise is essentially unwanted information that gets added along the required information due to certain environmental variations, faulty locations in a memory or during transfer [2]. Noise may be arise at the time of transmitting or clicking or taking images. Whenever noise is introduced, the each pixel present within the image show completely different values of intensity instead of the true pixel values. Image noise may be categorised as Impulse Noise (Salt & Pepper noise), Gaussian Noise (Amplifier noise), Multiplicative Noise (Speckle Noise), and Poisson Noise (Photon Noise).

1.1 Filtering

To recover the image from its noise there exits many median filtering techniques which are application oriented. Some filtering techniques have better effects than the others according to noise category. Median filtering techniques are described below

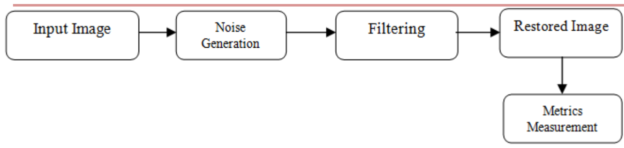

Figure 1: Flow of filtering techniques

II. PERFORMANCE METRICS

Study the performance of the detection schemes in distinctive the noisy pixels within the image at completely different impulse noise ratios [19]. In practice we have two types of analysis subjective and objective analysis .Subjective analysis is inconvenient, time-consuming and expensive. Lately, a lots of efforts are done to develop objective image quality metrics. MSE, PSNR, and IEF are the foremost normally used objective image quality measures. Full reference image quality measures can be classified into six categories of objective image assessment measures [20], that is:

a. Pixel difference-based measures: The mean square error (MSE), signal-to-noise ratio (SNR) and peakSignal-to-noise ratio (PSNR). These measures are easy to evaluate

b. Correlation-based measures: Correlation is used to measure the difference between two digital images. In image quality assessment, correlation of pixels is used as a measure of the image quality.

c. Edge-based measure: In this class the edges in the original and the distorted images are found, then a measure of displacement of edge positions or there consistency are used to find the image quality forthe whole image.

d. Spectral distance-based measures: Discrete Fourier Transform is applied on the original and the distorted images. The difference of the Fourier magnitude or phase spectral is used as a measure of image quality.

e. Context-based measures: Instead of comparing pixels in original and distorted images, pixel neighbourhoods are compared against each other by finding the multidimensional context probability to use it for measuring image quality.

f. Human Visual System-based measures (HVS): Here image quality is measured as the human eyewould do. Humans usually use contrast, color, and frequency changes in their measures.

The parameters required to assess the performance of the filters are defined as follows:

1) ***Mean Square Error (MSE)*****:** The two major error metrics that are used to compare the various image compression methods are the PSNR (Peak Signal to Noise Ratio) and the MSE (Mean Square Error).

2) MSE is the accumulative squared error [21] between compressed image and original image.

3) ***Peak-Signal-to-Noise-Ratio(PSNR):*** PSNR is a mathematical term to estimate the quality of reconstructed image as compared to that of original image[22]. It is defined as ratio between maximum power of signal(original data) and power of corrupting noise(error in reconstruction). Peak signal to noise ratio is commonly calculated in terms of logarithmic decibel scale. Higher PSNR indicates that image reconstruction is of higher quality. There is an inverse relation between MSE and PSNR. A lower value of MSE means less error. So accordingly, higher value of PSNR is good enough as it shows that the signal to noise ratio is higher where „signal" is the original image and „noise" is the error in reconstruction.

4) ***Image Enhancement Factors (IEF):***The image enhancement factor is the statistical approach used to measure the effectiveness

of the process used in the restoration of images. The higher the value of IEF better the process of conversion.

III. THEROY ON NON LINEAR FILTER

Nonlinear filtering techniques area unit enforced wide as a result of their superior performance in removing salt and pepper noise and conjointly conserving fine details of image [3]. There are many works on the restoration of images corrupted by salt and pepper noise. The median filter was once the foremost common nonlinear filter for removing impulse noise, due to its smart denoising power and procedure potency. Median filters are known for their capability to remove impulse noise as well as preserve the edges.

3.1. Standard Median Filter

In nonlinear strategies the median filter [4] is a nonlinear digital filter out that is regularly used in virtual image processing to lessen noise in an image. In exercise, besides decreasing noise, it's miles critical to hold the edges of an image as edges provide critical statistics at the visible look of an image. Median filtering is a smoothing approach that's effective in decreasing noise inside the smooth regions of an image. However can adversely affect the sharpness in edges. For small to slight tiers of salt and pepper noise the median clear out has shown to be useful in reducing noise at the same time as keeping edges.

Draw back and limitation of above algorithms are:

- With deteriorating performances at a high level of noise.
- Not suitable for high noise densities and does not preserve the image details like edges for further post processing.

3.1.1Switching median filter

The switching median filter [5] involves two steps impulse detector and filtering schemes. The various impulse detectors are proposed in the literature are, rank order based median filter, progressive switched median filter, adaptive center weighted median filter, laplician detector based switching median filter, pixel wise median filter, In switching median filter, there are two steps, First, a test decides whether or not a given pixel is contaminated by impulsive noise. A pixel is contaminated, if the absolute distinction among the median value in its community and the cost of cutting-edge pixel itself is more than a given threshold. If contaminated, a classical median filter is carried out. If no longer, the current pixel is noise unfastened and will now not be changed.

3.1.2Progressive Switching Median Filter

Progressive switching median filter [6] is used for putting off salt and pepper impulsive noise from the image. In this example first take one pixel check whether or not the pixel value is much less than the minimal price present in the window value and also check whether the pixel cost is extra than the maximum value present within the window then it is a corrupted pixel. Corrupted pixel is changed through median value. If the calculated median value is corrupted pixel, then growth the window length and recalculate the median value till get accurate median value.

Drawback and limitations of above algorithms are:

- Perform badly in noise detection, damage image details, and retain numerous impulses in the filtered images athigh noise ratios. To avoid the above problem, switching median filter with boundary discriminative noise detection (BDND) algorithm is proposed [7].
- Advantages of BDND algorithms are workswell with 90% of noise density, real timeapplications.

3.1.3Weighted Median Filter (WMF)

Weighted median filter is one of the branch of median filter out (WMF). The operations concerned in WMF are similar to SMF except that WMF [8] has weight related to every of its clear out element those weights correspond to the number of sample duplications for the calculation of median cost. However the successfulness of weighted median clear out in preserving image details is exceptionally dependent on the weighting coefficients and the character of the enter picture itself. Unluckily, in practical conditions, it's far difficult to find the proper weighting coefficients for this filter out, and this clear out requires excessive computational time whilst the weights are large.

3.1.4Centre Weighted median filter

It is a special type of median filter. CWM [9] is a filtering technique in which filter gives more weight only to the central value of a window, and thus it is less difficult to design and implement than general WM filters.

3.2 AdaptiveMedian Filtering

Adaptive median clear out (AMF) conjointly works in rectangular window space. Supported 2 forms of image fashions corrupted by using impulse noise [10] deliberate 2 new algorithms for adaptive median filters. These have variable window size for elimination of impulses while protecting sharpness. The number one, called the ranked-order based totally adaptive median clear out (RAMF), relies on a test for the presence of impulses inside the center detail itself observed with the aid of the test for the presence of residual impulses in the median clear out output. The second one, known as the impulse length based totally adaptive median filter (SAMF), is predicted on the detection of the dimensions of the impulse noise.

Draw back and limitation of above algorithms are:

- Above approaches might blur the image since both noisy and noise free pixels are modified.
- Existing systems uses fixed or different window size for detection of impulse noise. No algorithm is exist which can remove the noise from the edges of the gray scale image.
- Existing systems not provides consistent output in both low and high noise conditions.
- Exist systems are not well suited for real time applications because of these algorithms are time consuming nature.

3.2.1 Ranked-order based adaptive median filter (RAMF)

In RAMF, corrupted element is detected using minimum, most and median of the intensity values from the window under consideration [11]. Then corrupted element is replaced by median of the window that is not an impulse value and that is obtained by increasing windowsize until it reaches most window size.

3.2.2 Size based adaptive median filter (SAMF)

SAMF detects and replaces impulse noise of size one or a pair of or three elements by median filtering whereas noise free elements are replaced by mean of the window. It has been found that, the performance of AMF is good than that of median filters at low noise density levels. However, at higher noise densities, the edges are smeared significantly because maximum numbers of elements are replaced by median values which are less correlated with actual element value [5].

3.3 Decision based median filters

In decision based filters, the element is said to be corrupted if its value is either „0" or „255" otherwise the element is deemed as uncorrupted. To filter solely the corrupted elements different techniques are developed. Following Figure shows actual block diagram for removing noise from noisy image.

 ISSN: 2321-8169
6820 - 6828

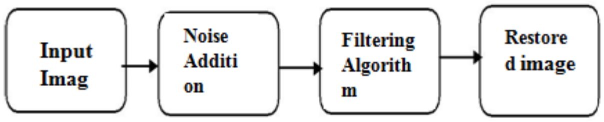

Figure 2: Block diagram for removing noise.

3.3.1 Decision Based Algorithm

A quick and efficient decision-based algorithm (DBA) for removal of high density impulse noises is given [12]. Impulse noise element will take the most and minimum values within the dynamic range (0,255). The DBA processes the corrupted image by 1st detecting the impulse noise. The detection of noisy and noise-free element is determined by checking whether the value of a processed element lies between the most and minimum values that occur within the chosen window. If the value of the element processed is within the range, then it is an uncorrupted element and left unchanged. If the worth does not lie inside this range, then it is a noisy element and is replaced by the average value of the window. At maximum noise densities, the median value may also be a noisy element in which case neighborhood elements are used for replacement; this provides higher correlation between the corrupted element and neighborhood element [13].

3.3.2 Decision based unsymmetric trimmed median filter (DBUTMF)

To overcome this disadvantage of DBA, decision based unsymmetric trimmed median filter (DBUTM) is conferred [14]. In decision based unsymmetric trimmed median filter, the central corrupted element is replaced by an average value of the elements in 3 x 3 window. This average value is obtained by trimming impulse values from current window if they are present. It is unsymmetric filter as a result of solely impulse values i.e. corrupted elements area unit are trimmed to obtain median of the window.

Flowchart of given algorithm is as follow.

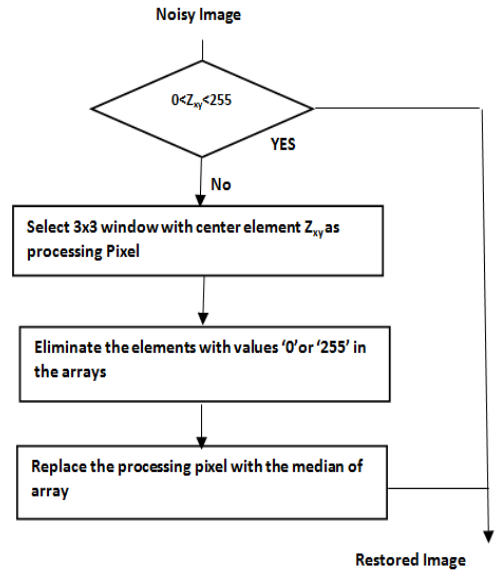

Figure 3: Flowchart for DBUTMF

3.3.3 Modified decision based Unsymmetric trimmed median filter (MDBUTMF)

As declared at high noise density, Decision based Unsymmetric trimmed median filter fail to offer appropriate performance for removal of salt pepper noise present in image and thus to beat this disadvantage, a modified decision based Unsymmetric trimmed median filter algorithm for the restoration of grey scale, and colour images that are extremely corrupted by salt and pepper noise is proposed [15]. During this algorithm each and every element of the image is checked for the presence of salt and pepper noise. The 3 totally different cases are illustrated for the processing element,

Case 1. If the chosen window contains salt/pepper noise as process element (i.e., 255/0 element value) and neighbouring part element values contains all elements that add salt and pepper noise to the image, then the average value will be again noisy. To solve this problem, the mean of the chosen window is found and the processing element is replaced by the mean value.

Case 2. If the chosen window contains salt or pepper noise as processing element (i.e., 255/0 element value) and neighboring element values contains some elements that adds salt (i.e., 255 element value) and pepper noise to the image. To remove the salt pepper noise from image initial the 1-D array of the chosen image region is obtained and therefore the 0 and 255 values will be eliminated and median of remaining array values is calculated. This calculated median value is then replaces the process element.

Case 3. If the chosen window contains a noise free element as a processing element, it does not need any processing.

The graphical representation of each case of given algorithm is shown in figure 4,

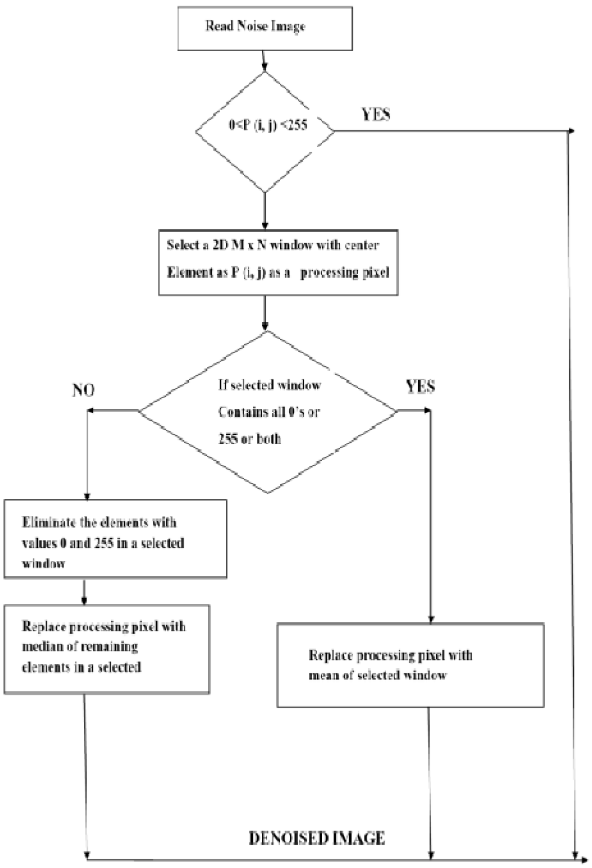

Figure 4: Flowchart of MDBUTMF

3.3.4 Improved decision based asymmetric trimmed median filter (IDBATMF)

The proposed Improved Decision Based Asymmetric Trimmed Median Filter (IDBATMF) algorithm processes the corrupted images by first detecting the impulse noise [16]. The processing pixel is checked whether it is noisy or noisy free. The pixel is considered as noisy only if it is 0 or 255, all the remaining pixels are left unaltered. If the processing pixel takes the minimum (0) or maximum (255) gray level then it is processed by proposed algorithm. The steps of the IDBATMF are elucidated as follows.

ALGORITHM: -

Repeat the below steps for each pixel of image.

If selected pixel is other than 0 or 255, it is uncorrupted pixel and it is left unaltered. Else process the pixel.

Step 1: If selected pixel is other than 0 or 255, it is uncorrupted pixel and it is left unaltered. Else process the pixel.

Step 2: Let Z (i,j) be the pixel being processed. Select a 2-D window of size 3×3 with Z (i,j) as the center element.

Step 3: If selected 3×3 window consists of all 0 or 255 or both then

a. If window has 6 or more 255's then replace Zi, j with 255.

b. Else if window has 6 or more 0's then replace Zi, j with 0.

c. Else replace Zi,j with mean of elements in the window.

Step 4: If selected window consists of other values as well, then eliminate 0's and 255's and find the median of remaining elements. Replace Zi,j with this median value.

3.3.5. Iterative Unsymmetrical Trimmed Midpoint-Median Filter

Iterative Unsymmetrical Trimmed Midpoint-Median Filter (IUTMMF) algorithm [17] was developed for the efficient restoration of grey scale images that are corrupted by salt and pepper noise. This algorithm is implemented in two phases. In the first phase midpoint-median filter is applied on the noisy image iteratively two times. In the second phase, modified decision based mean median filter (MDBMMF) is applied on the output of first phase.

IV. LATEST TRENDS

The recent methodology comprises the combination of decision based switching median filter and Negative Selection algorithm based on soft computing technique [18]. The negative selection algorithm (NSA) is one in all models in artificial immune systems. It is supported the discriminatory mechanism of the natural system. The purpose of the negative selection algorithm is to classify a trifle or string representations of real-world information, termed matter, as normal or abnormal. The algorithmic rule processes in 2 steps: learning and testing

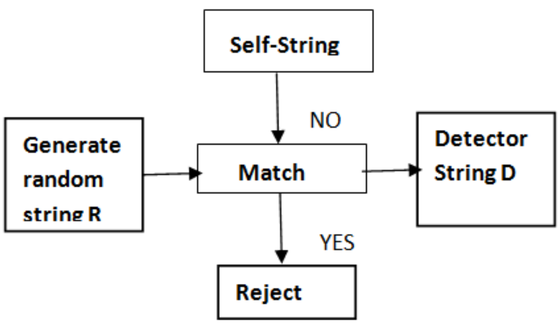

Figure 5(a):-Censoring phase

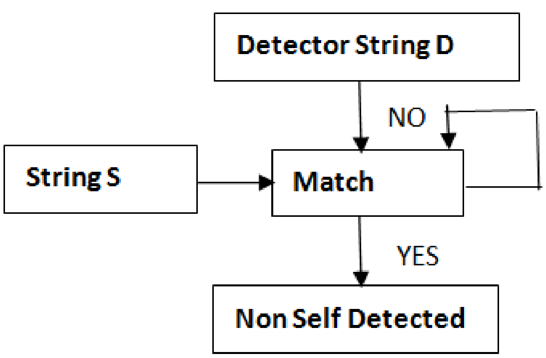

Figure 5 (b):-Monitoring Phase

The basic plan of the negative selection algorithm is to get variety of detectors within the complementary area. Then, apply these detectors to classify new, unseen, information as self or non self. The proposed method can reduce salt and pepper noise in an exceedingly corrupted image at high noise densities with large edge preservation.

Steps Proposed Algorithm:-

Step 1: Select image from computer memory into current program.
Step 2: Select the dimension size of an image.
Step 3: Repeat the following steps until end of file is not obtained.
Step 4: Collect all the pixels from mask.
Step 5: Check whether pixel values 0 or 255 are present or not.
Step 6: Eliminate all pixel values 0 or 255 and collect the remaining pixels.
Step 7: Evaluate the replacement using soft computing.
Step 8: Obtain the current value of median and apply on center pixel.
Step 9: Move filter on each pixels of an image.
Step 10: When all the corrupted pixels are removed we will obtain the filtered image.

V. CONCLUSION

The outline of the paper explores the numerous novel ways for the removal of high density noise from the digital image. All represented methods provide well line and detail preservation performance, for the constant time with effective removing noise from the input image. For de-noising an image, numerous filtering techniques are used however they need contradiction between noise removal and Edge preservation in an image. A new technique is used that removes the noise and conjointly preserve edges from image. The recent methodology include the combination of decision based switching median filter and negative selection algorithm which reduces salt and pepper noise in a noisy image at high noise densities with greater edge preservation.

References

[1] R.C.Gonzalez, R.E.Woods "Digital Image Processing" 3rd edition, Prentice Hall Publication.

[2] J. Astola and P. Kuosmaneen, Fundamentals of Nonlinear Digital Filtering, Boca Raton, FL: CRC, 1997.

[3] S Jayaraman, S EsaKkirajan, T VeeraKumar, "Digital Image Processing" Tata McGraw Hill, 2007.

[4] T. Nodes and N. Gallagher, "Median Filters: Some modifications and Their Properties," IEEE Trans.Acoustics, Speech, Signal Processing, vol. ASSP-30,no. 5, pp. 739-746, Oct. 1982.

[5] S. Zhang and M.A. Karim, "A New Impulse Detector for Switching Median Filter," IEEE Signal Processing Letters, vol. 9,no. 11, pp. 360-363, Nov.2002.

[6] 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.

[7] P.E. Ng and K.K. Ma, "A Switching Median Filter with Boundary Discriminative Noise Detection for Extremely Corrupted Images,"IEEE trans.Image Processing, vol. 15, no. 6, pp. 1506-1516, June 2006.

[8] R.K. Brownrigg, "The weighted median filter," Commun.Assoc. Comput, pp. 807–818, Mar.1984.

[9] S.-J. KO and Y.-H. Lee, "Center Weighted Median Filters and Their applications to ImageEnhancement," IEEE Trans. Circuits Systems, vol. 38, no. 9, pp. 984-993, Sept. 1991.

[10] H. Hwang and R.A. Haddad, "Adaptive Median Filters: New Algorithms and Results,"IEEE Trans. Image processing, vol. 4, no. 4, pp. 499-502, Apri1995.

[11] Xiaoyin Xu,E.L.Miller,D.Chen and M.sarhadi,"Adaptive Two-Pass Rank Order Filter to Remove Impulse Noise in Highly Corrupted Images,"IEEE Trans. Image Processing,vol. 13,no. 2,Feb. 2004.

[12] K. S. Srinivasan and D. Ebenezer, "A new fast and efficient decision based algorithm for removal of high density impulse noise," IEEE Signal Process. Lett. vol. 14, no. 3, pp. 189-192, Mar. 2007.

[13] Dodda Shekhar, Rangu Srikanth, "Removal of High Density Salt & Pepper Noise in Noisy Images Using Decision Based Unsymmetric Trimmed Median Filter (DBUTM)" International Journal of Computer Trends and Technology-volume2 Issue1- 2011, pp.109-114.

[14] K. Aiswarya, V. Jayaraj, and D. Ebenezer,"A new and efficient algorithm for the removal of high density salt and pepper noise in images and videos," in Second Int. Conf. Computer Modeling and Simulation, 2010, pp. 409-413.

[15] S. Esakkirajan, T. Veerakumar and C. H. PremChand "Removal of high density salt and pepper noise through modified decision based unsymmetric trimmed median filter" IEEE Signal Processing Letters, vol. 18, no. 5, pp. 287-290, 2011.

[16] Abhishek Kesharwani ,Sumit Agrawal ,Mukesh Kumar Dhariwal," An Improved Decision based Asymmetric Trimmed Median Filter for Removal of High Density Salt and Pepper Noise", International Journal of Computer Applications (0975 – 8887),Volume 84 – No 8, December 2013

[17] J. Kumar and Abhilasha, "An Iterative Unsymmetrical Trimmed Midpoint-Median Filter for Removal of High Density Salt and Pepper Noise," International journal of Research in Engineering and Technology, vol.3, pp.44-50, April 2014.

[18] Sarmandip Kaur, Navneet Bawa," Improved Negative Selection Based

Decision Based Median Filter for Noise Removal”, International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 4, Issue 5, May 2015.

[19] C. A. B. R. H. S. a. P. E. S. Z. Wang, "Image quality assessment: from error visibility to structural similarity," IEEE Trans. Image Processing, vol. 13, no. 4, pp. 600-612, 2004.

[20] I. A., B. S., K. S. Ismail Avcibas, "Statistical Evaluation of Quality Measures in Image Quality Compression," Journal of Electronic Imaging, 2002.

[21] Megha J Mane and M S Chavan “Design and Implementation of median filter for Image Denoising”.IJEETC.Vol.2, No.2, April 2013.

[22] YusraA.Y.AL-N ajjar, Dr. Der Chen Soong “Comparison of Image Quality Assessment.PSNR, HVS, SSIM, UIQI”. IJSER. Vol. 3, Issue 8, August 2012.ISSn 2229-5518.