Salt & pepper noise reduction in image de-noise using MMF technique

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***Abstract*: Noise free images are projected for good understanding of the data present in it. But due to many factors noise gets added and corrupts the image quality. Images are mainly affected by noise when they are transmitted over the unsecure channels. Mostly the images are infected by impulse noise due to faulty communications. Various filters are applied to make the images noise free in order to achieve the images with no or minimum signal distortion. Median filters are best suited digital on linear filters to remove the impulse noise from the images while preserved the edges of the images. In contrast to the unadventurous median filters, a decision based median filter is applied to detect the noisy pixels so that filter is applied only to the corrupted pixels thereby preserved the image features and leaving the uncorrupted pixels unscratched. In this paper we have presented a novel unsymmetrical trimmed median filter for removing the noise and to restore the Gray scaled and coloured images highly infected by impulse noise. A decision based filter first figures out the noisy pixels and then changes them by median value if other than 0 and 255values are present in the particular window and change the noisy pixels by the mean value of all the elements in the selected window if only 0's and 255's are present. The proposed algorithm is tested against different gray scaled and coloured images.**

***Index Terms*: Impulse noise, Median filter, trimmed median filter, Pixel expansion, window size, PSNR, salt and pepper noise.**

I. INTRODUCTION

In this world of advance technology, images have become a vital part in information exchange process. Digital images play an important role in today's multimedia content [9]. But these images get seriously affected by various types of atmospheric degradations which may occur due to environmental or human resources such as wind, temperature, pressure, lighting, hardware components of the transmitter and receiver, optical cables etc. it becomes difficult for the recipient to reveal the transmitted information if the images are affected by such degradations and it is necessary to enhance the degraded images. Various problems arise due to the presence of noise in the transmitted images and the type of noise added to the image. Sometimes, two types of noise signals get added to the image, thus demeaning the details. Figure 1 shows the effect of noise on real signals.
The essential issue is to eliminate the noise effectively thereby protecting the image details. There are certain factors due to which the image quality gets degraded; some of them are listed below. [11]

A. Factors degrading the images

Images may get corrupted and their performance degrades because of following factors: [10]

1) ***Contrast Degradation**:* The contrast of images is tarnished due to poor ambient conditions such as smog and mist. Contrast degrades due to spreading of light towards sensor by the air particles that in turn reduces image contrast with increase in distance of the camera and the object. Due to contrast degradation the resultant image may be under or over exposed because of poorly utilized dynamic range.

Fig 1: Effect of noise on real signal

2) ***Poor Focus:*** It introduces blur in image which is caused by lens aberrations, and shaking of camera or the capturing device with respect to ground.
3) ***Geometric Degradation:*** It causes distortion in shape of the displayed pictures. This degradation may result due to aberrations in the optical system, deflection non-linearity in camera and display tubes.

4) ***Noise Degradation:*** Depending on the source of degradation, noise generated in the images is referred as Gaussian, thermal, salt and pepper, and speckle, etc. This type of degradation occurs due to hardware limitation, atmospheric disturbance and device noise. It modifies the intensity value of image affecting the image details.

II. RELATED WORK

M.E.Yuksel et al [1] A two stage image filtering scheme has been proposed using neuro-fuzzy impulse detector. In the first stage, adaptive neuro-fuzzy system (ANFIS) based impulse noise detector is used to locate the noisy pixels while in the second stage, improved vector median filter is used to provide the correct value of the corrupted pixel. The filtering stage changes the pixels in the image when found corrupted by the noise. Simulation results indicate that the proposed scheme performs much better than other variants of vector median filter. For quantitative measurements PSNR peak signal to noise ratio is used for error in luminance values and normalized color difference (NCD) is used to measure the error in chrominance values of the image.

Tzu-Chao Lin et al [2] A fuzzy preservation-based total variation filter (FPTV) has been proposed for removal of random-valued impulse noise. In this de-noising scheme, adaptive center weighted median filter (ACWMF) is used to employ the variable window sized technique to improve its detection ability especially in highly corrupted images. The filter (ACWMF) not only checks whether a pixel is noisy or not but it also renders the confidence coefficient (CF) for each pixel to check its potential to be an impulse Then a function is designed with noise level p and CF as its arguments to determine pixel-wise the tradeoff between smoothness term and the data fidelity term in total variation energy functional. After minimizing the energy functional, we obtain the restored image. Simulation results showed that it outperformed some representative algorithms, both in vision and quantitative measurements like peak signal-to-noise ratio (PSNR) and mean absolute error (MAE).

V.R. Vijay kumar et al. [3] A novel decision based adaptive median filter has been proposed to remove blotches, scratches, streaks, stripes and random valued impulse noise in the images. It is a two stage algorithm. In the first stage, noise candidates are detected using rank ordered absolute difference (ROAD) value while in the second stage, replacement is done by median of the uncorrupted pixels in the filtering window. The filtering window is varied adaptively based on the number of uncorrupted pixels in the window. The proposed technique is very effective in removing random valued impulse noise up to a noise density as high as 60%.The main advantage of the proposed work is easy to implement in hardware and fast execution time.

A.S.Awad et al [4] A new filtering scheme has been presented based on the contrast enhancement within the filtering window for removal of random-valued impulse noise. The application of the non-linear function for increasing the difference between noisy pixel and a noiseless one results in efficient detection of noisy pixels. As the performance of the filtering system, in general, depends upon the number of iterations used. So, the detection of the noisy pixels depends upon the iterative applications of a non-linear function that progressively increases the gray scale level between noisy and noiseless pixels. The performance of the proposed scheme has been compared with many existing noise detection techniques. The experimental results exhibit significant performance or better efficiency over several other techniques.

Pankaj Kr. Seat al [5] various efforts have been made for highly corrupted images. A new method is proposed i.e. MWB (Modified Weighted based) filter which is based upon the weighted difference with its current pixel and its neighbors aligned with four main directions. This filter makes full use of the impulse to detect and restore noise. Simulations showed that this filter provides optimal performances of suppressing impulse with high noise level which may enhance the performance. Simulations also showed that this filter performs much better than many existing median-based filters in both subjective and objective (PSNR) evaluation. Especially on some specific corrupted images, the proposed filter (MWB) gives better embedded images than that of the DWB filter. Since PSNR shows the ratio between the maximum possible powers of the signal to that of the corrupted noise, hence higher the PSNR, better is the quality of the image.

X.Zhang et al[6] A novel de-noising method has been proposed, which is based on the decision-tree and edge-preserving techniques for the removal of random-valued impulse noise. In this approach decision-tree based detector is used to detect the noisy pixel and an effective design is employed to locate the edges. Extensive experimental results showed that the proposed technique not only preserved the edge features, but also obtained excellent performance in terms of quantitative evaluation and visual quality. Furthermore, the design requires very low computational complexity and suitable for real-time embedded systems. This technique worked with monochromatic images, but it can be extended for working with RGB color images and videos.

Awadhesh Kumar Singh et al [7] A two-stage Noise Adaptive Fuzzy Switching Weighted Median (NAFSWM)for eliminating fixed-valued and random-valued impulse noises. This filter is able to suppress up to 90% of noise. It does it require any further tuning or training of parameters once optimized, preserving fine image details, edges and textures.

C.C.Lien et al. [8] An efficient de-noising scheme for impulse noise has been proposed. The proposed scheme estimated noisy or noisy-free for the detected pixel in terms of the most probable edge of the 3*3 window. Then the detected pixel is replaced by the median value of the most probable edge, if it is noisy. The proposed scheme efficiently removed fixed-valued and random-valued impulse noise sources while preserving image edges. It has better image quality than those of the conventional linear and non-linear filters. The proposed scheme also maintained the edge of the restoration image due to preserving image edge details. Because of its simple procedure, it is suited for real-time applications and hardware implementation.

Bo Fu, Xiao-Yong Zhao et al. [13] In this paper proposed an image de-noising algorithm where first generative model is build on a patch as a basic unit and then the algorithm locate the image noise with that patch in order to better illustrate the patch and attain better successive clustering. Second algorithm classified patches using a generative clustering method, thus prove additional resemblance information for noise renovate and suppress the interference of noise, also neglected those categories that consist of a smaller number of patches .Finally, the algorithm builds a non –local switching filter to remove the salt and paper noise.

Cristy M. Bangug et. Al. [14] Median filtering is a non-linear kind of image filtering which is efficiently used in reducing the image noise while maintained the edge of the image. One benefit of median filtering is eliminating the effect of input noise values with very large magnitudes. Median filtering reduced noise from an image without edge demolition and blurring but the performance will be corrupted in a high density of noise. The process was modified by identifying the noise density of the image and the window size of the image will be the basis to be used in sorting the pixels.

III. PROPOSED APPROACH

In the proposed approach, we have used the Salt and Pepper based Noise Model. Noise is detected using the value of the pixel. If pixel lies in (0, 255) then its non-noisy otherwise it's noisy. For filtering of noisy pixel, we have used the Median filtering method. The following steps are involved in the proposed approach:

- Step 1: For each pixel P(i, j) in the image, make a sliding window of size M (3×3).
- Step 2: Check the central pixel of sliding window for noisy using salt and pepper method. If value of central pixel lies in (0, 255) then it indicates that pixel is not noisy otherwise pixel if noisy.
- Step 3: If pixel is not noisy then go for next selected pixel in step 1 otherwise go to step 4.
- Step 4: Identify the good pixel in the neighboring window.
- Step 5: Apply the median filtering on all the good pixels. If all the pixels are corrupted, then replace the output with the previous sliding window output.
- Step 6: The performance of the proposed algorithm is analysed for different grey scaled and coloured images and evaluated in terms of MSE (mean square error) and PSNR(Peak signal to noise ratio) by varying the noise densities from 10% to 70% as given by the equations 1 and 2 respectively.

$$\text{PSNR (dB)} = 10 \log_{10}\left(\frac{255^2}{MSE}\right) \text{ ....Eq. 1}$$

$$\text{MSE} = \frac{\sum_i \sum_j (Y(i,j) - \widehat{Y(i,j)})^2}{M*N} \text{ ....Eq. 2}$$

Size of the image is represented by M * N
Y represents the real image,
Ŷ Represents the de-noised image.

The proposed algorithm is computationally fast and efficient than the conventional median filters.

IV. EXPERIMENTAL RESULTS

Proposed filtering approach has been tested on two images in grey scale and colored form on different noise levels varying from 10% to 70%.

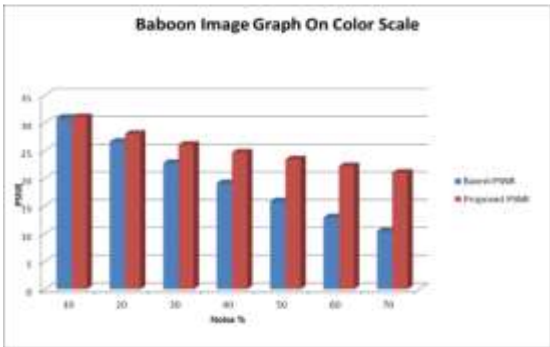

Fig.10: PSNR comparison for colour image shown in figure 12 on different noise %

Fig 11: Original colour image of baboon

fig.12

fig.13

Fig 12: (a) Original colour image with 10% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 13: (a) Original colour scale image with 20% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

fig.14

fig.15

Fig 14: (a) Original colour image with 30% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 15: (a) Original colour image with 30% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

fig.16

fig.17

Fig 16: (a) Original colour image with 40% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 17: (a) Original colour image with 60% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

fig.18

Fig 18: (a) Original colour image with 70% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Figure 10-18 are justifying the comparative analysis shown in figure 18.

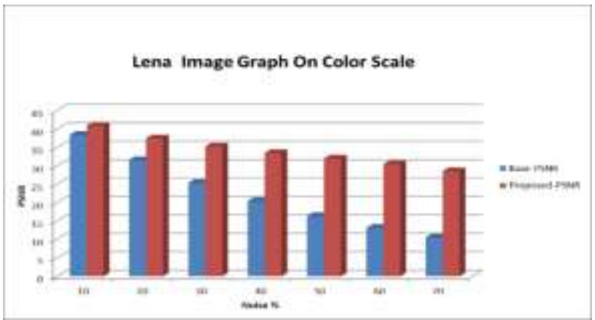

Fig 20: PSNR comparison for colour image shown in figure 30 on different noise % Fig 21: Original colour image of Lena.

Fig.22

fig.23

Fig 22: (a) Original colour image with 10% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 23: (a) Original colour scale image with 20% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.24

fig.25

Fig 24: (a) Original colour image with 30% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 25: (a) Original colour image with 40% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.26

fig.27

Fig 26: (a) Original colour image with 50% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 27: (a) Original colour image with 60% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.28

Fig 28: (a) Original colour image with 70% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Figure 20-28 are justifying the comparative analysis shown in figure 28.

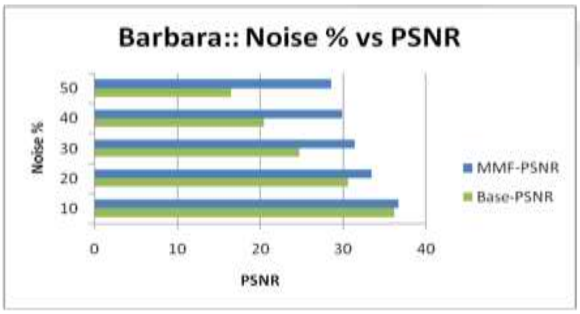

Fig 30: PSNR comparison for colour image shown in figure 30 on different noise % Fig 31: Original colour image of Barbra.

Fig32

fig.33

Fig 32: (a) Original colour image with 10% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 33: (a) Original colour scale image with 20% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.34

fig.35

Fig 34: (a) Original colour image with 30% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 35: (a) Original colour scale image with 40% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.36

fig.37

Fig 36: (a) Original colour image with 50% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig 37: (a) Original colour scale image with 60% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Fig.38

Fig 38: (a) Original colour image with 70% noise (b) Image after de-noising using approach given in [12] (c) Image after de-noising using proposed approach

Figure 30-38 are justifying the comparative analysis shown in figure 38.

V. Conclusion

In this paper, authors have proposed Modified Median Filtering for Salt & Pepper Noise in Image Denoise for the elimination of impulse noise from the images to be transmitted over unsecure channels. The paper has presented the visual as well as the quantitative results that showed that the proposed algorithm is effective for removal of salt and pepper noise from images at low as well as high noise densities. The results were compared with already existing approach given in [12] and the proposed mmf filter proved to be better with the increase of noise content in the image.

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