Improved Median Filtering in Image Denoise

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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 contaminated by impulse noise due to defective 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 preserving the edges of the images. In contrast to the conventional 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 preserving the image features and leaving the uncorrupted pixels unharmed.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 grayscaled and coloured images.

Keywords— *Impulse noise, Median filter, trimmed median filter, Pixel expansion, window size, PSNR, MSE, salt and pepper noise.*

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1. 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 [1]. 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.

A. Factors degrading the images

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

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.

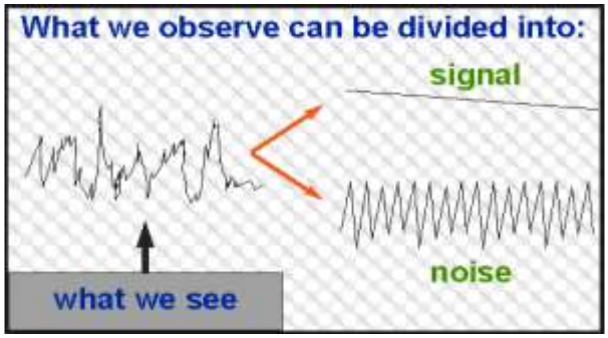

Fig 1: Effect of noise on real signal

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.

2. RELATED WORK

Author has reviewed some of the research papers and to gain some background knowledge to study the factors causing noise degradation and to study the already developed noise removal techniques.The following sections explain more about noise degradation in images.

A. Factors causing Noise Degradation

Distortion of image due to presence of noise in the real signal is the commonly faced problem during image transmission. Amer& Dubois in [2] had discussed the factors due to which noise is introduced during transmission. The various factors may be camera sensors; poor lighting conditions etc. Transmission over satellite, or other unsecure communication channels, or through lossy networked cables etc. also add to noise. Many researchers have identified common types of noises as impulse noise, guassian noise, shot noise, multiplicative noise, Gaussian noise etc. Raymond et al in [3] have discussed the impulse noise in which the affected pixels are changed by noise values of 0 for low (dark) and 255 for high (white) values which are present at arbitrary places over the image. Additive noise which is also known as Amplifier noise widely affects the image sensors was discussed by Jun Liu et al in [4]. Shot noise, which appeared due to geometric quantum undulates in image sensor, was discussed by Hoshino et al in [5]. Multiplicative noise; in which the intensity of the noise value was multiplied with the intensity of the pixel was discussed by Roomi & Rajee in [6].

In Gaussian noise a random value is added to each pixel of an image. Cloudy nature is the prime challenge in radar applications. Synthetic Aperture Radar image is naturally degraded by noise. When a SAR image is formed by the radar waves travelling back after striking various targets, a pixel-to-pixel discrepancy in concentration appears as a salt-and-pepper noise or fading that was studied by Goodman in [7] and by Lee et al. in [8]. In medical field images obtained from ultrasound machines are affected by speckle noise (multiplicative noise) which contains medical information that is helpful in diagnosis of a disorder. Degraded images can be improved for deliveringinformation and there by meeting the user requirements through various noise filtering techniques.

B. Noise Removal Techniques

Though various corrective measures have already been proposed but the introduction of noise and degradation of images is inevitable; this in turn degrades the image quality. So, removing the noise from the vital fields concerned with image processing has become utmost important. Mehmet Emin Yuksel et al. in [9] found out that low contrast images are affected by impulse noise. Many efforts have already been made to make the images noise free and to make them interpretable. In last thirty years the commonly used digital filter as suggested in [10] is Standard Median Filters (SMF). In past decades, 1-D or 2-D median filters have been passed through various moderations and have found applications in vast area such as in digital TVs, image denoising, cryptography, image processing, image analysis, speech processing etc. because of its simple computational structure and efficiency. The non linear filters are noise specific so non adaptive filters cannot work efficiently if the image and noise statistics are unknown. Type of noise varies from image to image in different applications. For varying noises, Adaptive filters can be employed to achieve better performance. For preserving the details of the signal and eliminating the noise Adaptive Median Filter was proposed by Bernstein in [11], which simultaneously removed a combination of additive random noise and mixed impulse noise from the images.

Various Adaptive Median Filters as proposed by Bernstien in [11], Nahi and Habibi in [12], Biglieri et al. in [13], Sicuranza and Ramponi in [14], Manikandan et al. in [15], Rabie in [16] all were capable of adjusting their window length depending on the edge or flat region image in the area being filtered and the local signal to noise ratio. Chen et al. in [17] have proposed an approach for removal of pepper and salt noise. Authors have classified the pixels in two classes: noise free and suspected noise. To identify the suspected noise pixels, author has counted the noise free pixels and closed grey levels in the neighborhood. After detecting the noisy pixels, next step was the removal of noisy pixels. For this, authors have used the adaptive filtering algorithm with weighted mean based on Euler distance. Through experimental results, author has shown that the proposed methodology has effectively removed the pepper and salt noise.

3. 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 its 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 neighbouring 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.

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

  MSE=$\frac{\sum_i \sum_j (Y(i,j) - \hat{Y}(i,j))^2}{M*N}$..................................Eq. 2
  size of the image is represented by M * N
  Y represents the real image,
  $\hat{Y}$ represents the Denoise image.

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

4. 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%.

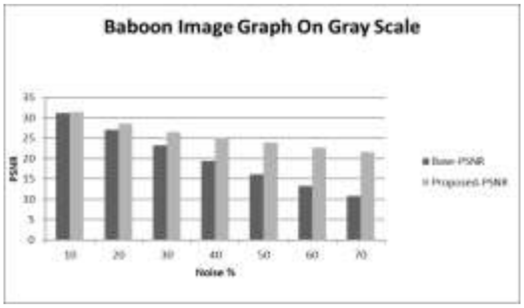

Fig 2: PSNR comparison for grey scale image shown in figure 3 on different noise % Fig 3: Original grey scale image of baboon

fig.4

fig.5

Fig 4:(a) Original grey scale image with 10% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Fig 5: (a) Original grey scale image with 20% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

fig.6

fig.7

Fig 6: (a) Original grey scale image with 30% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Fig 7: (a) Original grey scale image with 40% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

fig.8

fig.9

Fig 8: (a) Original grey scale image with 50% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Fig 9: (a) Original grey scale image with 70% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Figure 4-9 are justifying the comparative analysis shown in figure 2.

Figure 4-10 are justifying the comparative analysis shown in figure 2.

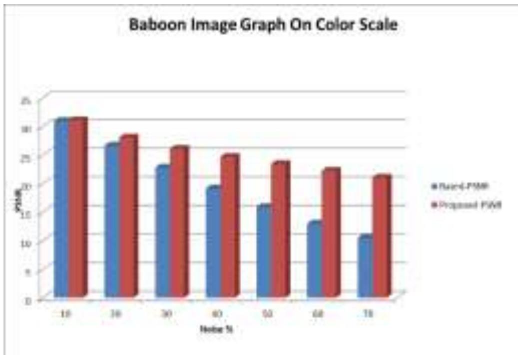

Fig 10: PSNR comparison for colour image shown in figure 12 on different noise %

Fig 11: Original colour image of baboon

fig.12

fig.13

Fig 12: (a) Originalcolour image with 10% noise (b) Image after de-noising using approach given in [17] (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 [17] (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 [17] (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 [17] (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 [17] (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 [17] (c) Image after de-noising using proposed approach

fig.18

fig.19

Fig 18: (a) Original colour image with 60% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Fig 19: (a) Original colour image with 70% noise (b) Image after de-noising using approach given in [17] (c) Image after de-noising using proposed approach

Figure 10-19 are justifying the comparative analysis shown in figure 11.

CONCLUSIONS

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 shows 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 [17] and the proposed filter proved to be better with the increase of noise content in the image.

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