A Study and Analysis of Image Denoising Techniques and Design of a Fuzzy Peer Group Membership Filter for Color Images

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***Abstract*- The main objective of this paper is to study and analyze the various denoising techniques for color images. Here we compare various filters and the removal of poisson noises in color images. The new filter is capable of reducing Poisson noise from noisy images effectively. Images are corrupted by noises during acquisition and Denoising is the process of removing noises from various images. Here the method detects the noise and reduces the noises from color images. We use Fuzzy median filter to remove impulse noise and fuzzy averaging concept to remove Gaussian noise and Discrete Wavelet Transform to remove Poisson noise.**

I. INTRODUCTION

Digital images are corrupted during acquisition and transmission by noise. Suppressing the noise while keeping the image features like edges, textures is the main problem in denoising. During the image acquisition, Gaussian noise is added into the original image and during transmission, impulse noise is added to the original image. Poisson noise is added in the image of astronomy and astrophysics. Nowadays TV images are corrupted due to atmospheric interference and imperfections during the reception of the image. Noise gets introduced while scanning the damaged surface of the originals. In digital cameras the noise may get introduced because of CCD sensor malfunction or also due to flaws in data transmission. Source and detector in micro array technology causes CDNA microarray image imperfections. Many filters are designed for Gaussian noise suppression to take advantage of thee zero mean property of the noise and to suppress it by locally averaging pixel channel values. The need for efficient image restoration methods has grown with the massive production of digital images and movies of all kinds, often taken in poor conditions. No matter how good cameras are, an image improvement is always desirable to extend their range of action. A digital image is generally encoded as a matrix of grey level or color values. In the case of a movie, this matrix has three dimensions, the third one corresponding to time. Each pair (i; u(i)) where u(i) is the value at i is called pixel, for picture element. In the case of grey level images, i is a point on a 2D grid and u(i) is a real value. In the case of classical color images, u(i) is a triplet of values for the red, green and blue components. All of what we shall say applies identically to movies, 3D images and color or multispectral images. For a sake of simplicity in notation and display of experiments, we shall here be contented with rectangular 2D grey-level images.

The two main limitations are the noise and blur. Blur is intrinsic to image acquisition systems, as digital images have a number of samples and must respect the Shannon-Nyquist sampling conditions. Noise is the second main image perturbation. Each one of the pixel values u(i) is the result of a light intensity measurement, usually made by a CCD matrix coupled with a light focusing system. Each captor of the CCD is roughly a square in which the number of incoming photons is being counted for a fixed period corresponding to the obstruction time. When the light source is constant, the number of photons received by each pixel fluctuates around its average in accordance with the central limit theorem. In other terms one can expect fluctuations of order for n incoming photons. In addition, each captor, if not adequately cooled, receives heat spurious photons.

This paper compares the performance of various filtering techniques namely Method A, B, C and D. These methods based on computing the RGB variance

II. METHODOLOGY

A. Peer Group

Let I be the original image which is to be processed. In that image each pixel consists of three components that is Red, Green and Blue. The peer group is defined as the set of pixels which are neighbors and also which are similar to it. There are many ways to define this set. Here wee use the distance threshold to find which pixel belongs to this set that is the peer group. Using this peer group we can decide which pixel is free of impulse noise and also this may be used to smooth the Gaussian noise. Then fuzzy logic concept can be used and we call it as fuzzy peer group.

B. Determining the Fuzzy Peer Group

In the fuzzy peer group concept we use a fuzzy similarity function. We have chosen this function because it is a fuzzy metric according to the concept given by George and Veeramani, [99], [100], and this class of fuzzy metrics has been proven to be appropriate for fuzzy color image processing [41]–[43], [48], [52]. To establish the concept of fuzzy peer group we define two fuzzy sets on the ordered set of pixels . One set represents the fuzzy set and the other set represents the accumulated similarity.

C. Best Number of Members for a Fuzzy Peer Group

The best number of members for a fuzzy peer group of a given pixel are constituted by the pixels which are similar to the pixel and the remaining pixels are not included in it. Here we introduce two fuzzy rules. One rule is to identify the best number of members and the other rule is to identify the pixels which are free from impulse noise. Why we construct these rules are these are rule based. Here the similarity concept works remarkably well. The similarity measure should be larger to get the maximum number of best members for a fuzzy peer group. If this is larger then we get the maximum number of clusters in the particular neighborhood. This fuzzy peer group helps us to identify and remove the impulses based on the threshold based rule.

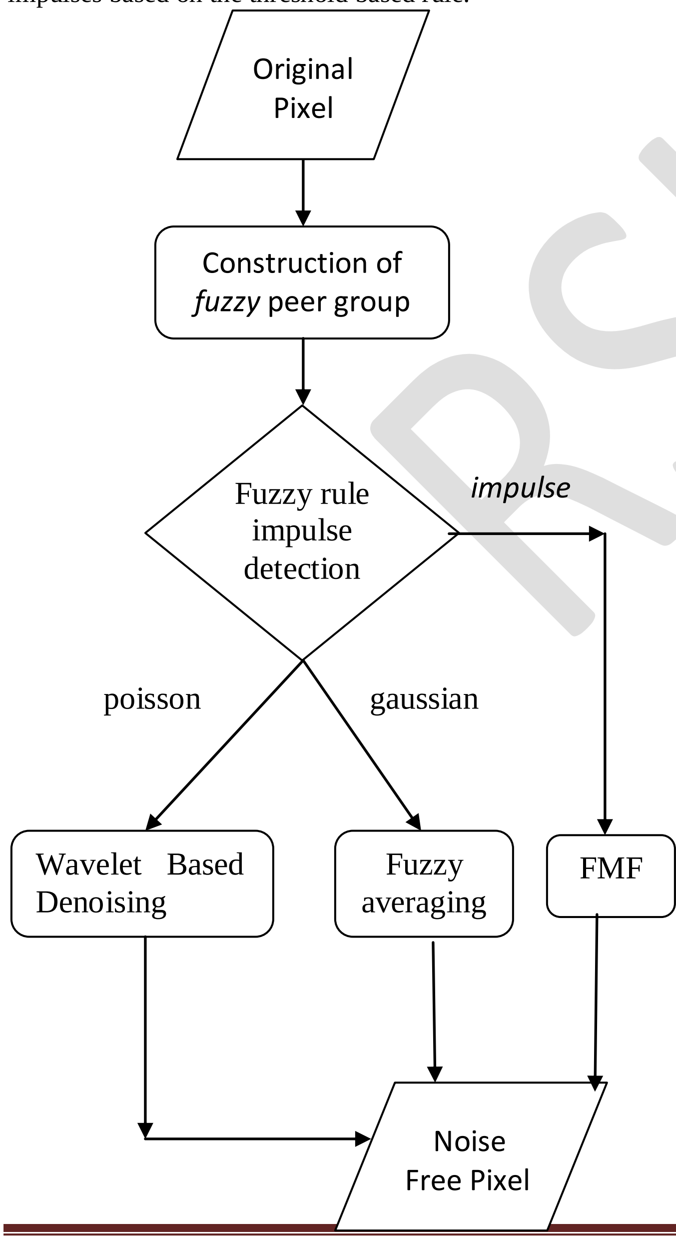


Fig. Diagram of the filtering process applied to each image pixel

There are two main steps involved in the filtering process. First step is impulse noise detection and reduction and the second step is Gaussian noise smoothing.

1. Impulse Noise Detection and Reduction

In the impulse noise detection and reduction we use the Fuzzy Median Filter to effectively remove the noise. This is done by identifying the similar pixels and replaces the impulses according to the threshold. Here no additional computation is needed since already all the computation has been performed.

2. Gaussian noise smoothing

In Gaussian noise smoothing procedure we use the concept of fuzzy averaging. This simply performs the weighted averaging operation among the three color components. This preserves the edge and detail for the similar color components and this does not work on nonsimilar color components.

3. Poisson Noise Smoothing

For poisson noise smoothing we use wavelet based Thresholding. Here for the original image Discrete Wavelet Transform is applied. Then it is divided into four bands. They are LL, LH, HL and HH. Noise estimation is done on each band. Then according to the noise estimation we should find the threshold. Soft Thresholding is applied which means according to the threshold particular values are removed and finally the noise free bands are combined to get the poisson free image.

III. RESULT & ANALYSIS

A. EXPERIMENTAL RESULTS

To evaluate the performance of the denoising techniques several performance metrics are available. We use the PSNR to analyses the performance.

Peak Signal-to-Noise-Ratio

We use the peak signal-to-noise ratio (PSNR) to evaluate the quality between the denoised image and the original image. The PSNR formula is defined as follows:

$$PSNR=20 \log 2^n-1/RMS$$

$$RMS= \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - x'_i)^2}$$

where H and W are the height and width of the image, respectively; and f(x,y) and g(x,y) are the grey levels located at coordinate (x,y) of the original image and denoised image, respectively.

The proposed system is implemented using a IDL program where it is evaluated for denoising the image.The performance of the algorithm is evaluated on several real images. These pictures are the most widely used standard test images used for denoising algorithms. The image contains a nice mixture of detail, flat regions, shading and texture that do a good job of testing various image processing algorithms. These are till in the industry standard for tests. It is a good test images. These images are used for many image processing researches. In this project we can evaluate these images by the time taken value and PSNR value. The pictures in Figure are used for the experimental analysis.

The PSNR values for the various denoised images are calculated by using the proposed algorithm. The result is given below.

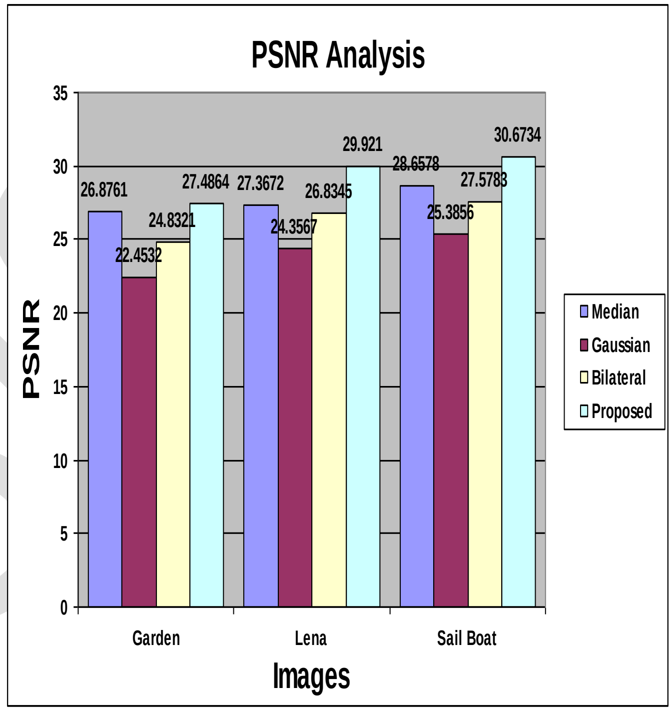
	Median	Gaussian	Bilateral	Proposed
Garden	26.8761	22.4532	24.8321	27.4864
Lena	27.3672	24.3567	26.8345	29.9210
Sail Boat	28.6578	25.3856	27.578	30.6734

TABLE 7.1. Performance Analysis of PSNR Value

Garden Image

Sail boat image

Lena image



IV. CONCLUSION

This paper is used to effectively remove noise like impulse , Gaussian and poisson noise using various methods. First we use the Fuzzy peer group concept to find the similar pixels and based on that we remove the impulses. And the Fuzzy averaging concept to smooth the Gaussian noise and to remove poisson noise we use Wavelet based Thressholding. It performs well to remove mixed noises also.

A mathematical model and theoretical development will be pursued in our future work.

Future work of this project are listed below

1. Instead of remove salt-and-pepper noise and Gaussian and impulse noise, it will remove various noise.
2. It will be used for video to remove the noise.

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