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Simulation of Hybrid Filter Model to Enhanced the Quality of Noisy Images

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***Abstract*—The objective of this paper, provide the simulation steps of hybrid filter model that consists image denoising and image enhancement implementation over three different noises such as Salt and Pepper (SPN), Gaussian noise, Speckle (SPKN) with different noise variance in range .02 to .14. Hybrid filter works on spatial filtering techniques such as median filter and high pass filter that is operate on neighbourhood pixels. Median filter technique is used for smoothness and other(High pass) for sharpening of images and extracting the useful information in analysis process for image processing because of the input images are not always in good quality. The same concept is applied to the different images and they are compared with one another. The performance measurement is proposed with the help of Mean Square Errors (MSE), Peak-Signal to Noise Ratio (PSNR) and Signal to Noise (SNR) .So as to choose the appropriate noise for different filtering methods for any image. Result has simulated on MATLAB R2007b.**

Keywords- Different MRI image, , image noise, Filter, Median Filter, High-pass Filter, MSE, PSNR and SNR.

I. INTRODUCTION

In hybrid filter model, Noise is removable using iterative median and image sharpening using high pass filter in spatial domain which requires much less processing time than removal by frequency domain Fourier [1].The objective of image enhancement is to improve the quality of image. An enhancement algorithm is one that yields a better quality image for the purpose of some particular application which can done by either suppressing the noise or increasing the image contrast. Image enhancements algorithms are employed to emphasize sharpen the image features for display and analysis. The high pass and high-boost filter will work on high-frequency components of images. Image enhancement techniques emphasize specific image features to improve the visual perception of an image [2].Filtering technique can not remove more than one noise at the same time.

1.1 Spatial Domain Method

A spatial domain method is an image operation where each pixel value is changed by a function of the intensities of pixels in a neighbourhood. Spatial domain is a simple manipulation of neighbourhood pixels [3].

II. IMAGE NOISE

Image noise represents unwanted information which degrades the image quality to enhance the quality we use filtering. Noise is defined as process(n) which add with original image(s) and effects the acquired image(o).

$$o(i\ ,j)=s(i\ ,j)+n(i\ ,j) \quad (1)$$

Noise may be appears in image from different-different source. The digital image acquisition process, which converts an optical image into a continuous electrical signal that is then sampled, is primary process by which noise appears in digital image. There are several ways through which noise can be introduced into an original image, depending on types of noise [4].

III. PROPOSED METHODOLOGY

In proposed methodology, we have combined the different filtering techniques into single one is called hybrid filter. There are three different noise sources as possible noises are salt and peppers, Gaussian and speckle noise will be added to original image here we want to improve the quality of image enhancement. The noise will be common for the median filter it is used for denoising then to improve the quality of image through high pass filtering. The hybrid model Shown in figure

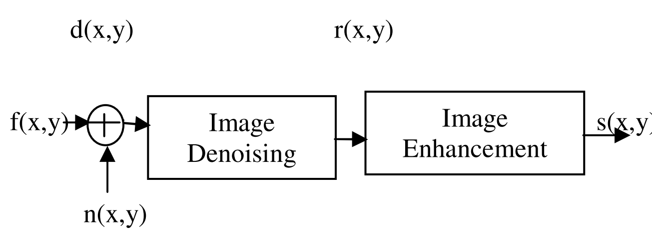

Fig. No.1- Hybrid Model

There are three different noise source as possible noises are salt and peppers, Gaussian and speckle noise will be added to original image. The noise is common for the median filter it is used for denoising then to improve the quality of image through high pass filter. At last three outputs are generated we select the appropriate output [5].

Simulation result will be carried out using any images, here one image is chosen for demonstration. The performance evaluation of the filtering operation is quantified by the PSNR (Peak Signal to Noise Ratio) and MSE (Mean Square Error) PSNR is most commonly used to measure the quality of reconstruction of noisy image [6]. The signal in this case is the original data, and the noise is the error introduced by compression MSE measures the average of the squares of the errors. The error is the amount by which the value implied by the estimator differs from the quantity to be estimated by some expressions.

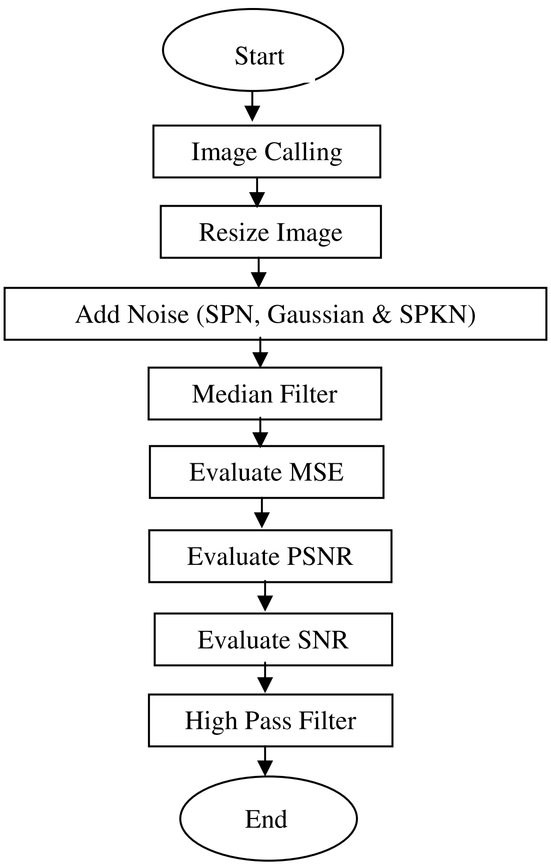

Fig No.2- Proposed Method

The MSE, PSNR and SNR are calculated, given a noise-free m×n monochrome image *I* and its noisy approximation *K*, MSE is defined as [7]:

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

PSNR is defined as:

$$PSNR = 10.\log_{10} (255^2/MSE) \qquad (3)$$

SNR is defined as:

$$SNR = 10\log_{10}((1/(m \times n)) \sum_{i=0}^{m-1} \sum_{j=0}^{n-1} [I(i,j)]^2/MSE) \qquad (4)$$

IV. PROPOSED ALGORITHM

In this algorithm we describe the stepwise, detailed methodology that is followed while denoising images using median filter technique and image enhancement using highpass filter technique on common parameters like the noise used i.e. Gaussian noise, speckle noise and speckle noise.

4.1 Algorithm of Median Filter

1. Read the original standard image dynamic by nature.
2. If called image is 3d image then convert image into gray scale.
3. Resize the loaded image to a standard size of 256 × 256. Because for large sized images, such as 512× 512, the computation time for denoising is found to be more. And if the image size is taken smaller than 256× 256, then the useful data is liable to get lost.
4. Noise is added to the standard test images of available noise. All of these noises discussed in 1.4 such as Salt and pepper, Speckle noise & Gaussian noise.
5. Median filtering is accomplished using the medfilt2 function.
6. After reconstruction of an image three parameters i.e. MSE (Mean Square Error), PSNR (peak signal to noise ratio) and SNR(signal to noise ratio)are calculated for all the standard images with their noisy and denoised counter parts, respectively. Hence, we get a good amount of comparison between the noisy and denoised images keeping the set standard image intact.
7. Go to step 3 until each noise is not added with different variance.

4.2 Algorithm of High Pass Filter

1. Load the original image I.
2. Convert the colour space.
3. Resize the loaded image to a standard size of 256 × 256.
4. Add noise to the standard test images of available noise such as salt & pepper, Gaussian noise and Speckle noise.

5. The output of median filter will be input for highpass filter.
6. Denoised filter is accomplished using median filter.
7. Highpass filter is accomplished using the following steps.
a. Convert the standard image into double,
b. Assign the size of image to array

$$[\ r\ c] = \text{size}(f). \qquad (5)$$

c. Read the array [r c] by i and j variable and calculate the pixel values

$$ip = i+1, im = i-1, jm = j-1, jp = j+1. \qquad (6)$$

$$S(i,j) = 9*f(i,j)-1*(f(i,jm)+f(i,jp)+f(ip,j)+f(im,j)+f(im,jm) + f(ip,jm)+f(ip,jp)+f(im,jp)).$$

8. Go to step c until every pixel is not covered.

V. SIMULATION RESULTS

The validation that has been developed to compute our algorithm on a real machine is written in the MATLAB 7.5 (R2007b). And the performance computation measured by MSE, PSNR and SNR. The simulation is only given for salt and pepper noise.

5.1 Image Calling

Dynamic image calling is a process that loads the original image from anywhere.

Input:
Load an input image 'brain3.jpg'.
Initialize row value.
Initialize column value.
A = imread('brain3.jpg');

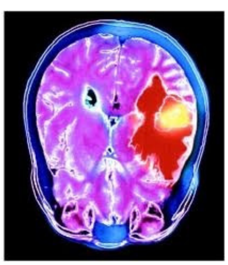

Fig No.3: Input Image

If called image is coloured then convert into intensity level using rgb2gray() function. The gray image is shown in figure and pixel value given below:

B = rgb2gray(A);

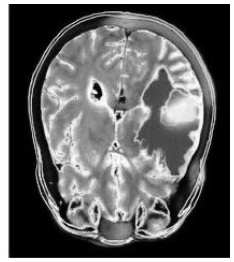

Fig No.4: Intensity Image

Table 1: Pixel Value of Original Image

249	173	141	147	148
243	67	0	0	0
245	68	0	2	0
246	65	0	3	1
248	68	0	0	0

5.2 Added Noise

Noise is unwanted information that adds with original image and changes the properties of image.

Input:
Call an original image 'B'.
Initialize row value.
Initialize column value.
C = imnoise(B,'salt & pepper',0.02);

Image shown in figure and noisy matrix given below:

Fig No.5: Added Salt & Pepper Noise

Table 2: Pixel Value of Noisy Image

249	173	141	147	148
243	67	0	0	0
245	0	0	2	0
246	65	0	3	1
248	68	0	0	0

5.3 Denoised Technique

A median filter is smoothing method. Median filter performs the following tasks to find each pixel value in the processed image [1]:

1. All pixels in the neighbourhood of the pixel in the original image which are identified by the mask are stored in the ascending order.

2. The median of the stored value is computed and is chosen as the pixel value for the processed image.

Input:
Call a noisy image 'C'.
Initialize row value.
Initialize column value.
D = medfilt2(C);

We can get the denoised pixel conclude by the following steps, the noisy matrix given below. We are taking 3x3 matrix of noisy at a time.

Table 3: Noisy Matrix

249	173	141
243	67	0
245	0	0

1. The pixel values are arranged in ascending order as-

00 0 67 141 173 243 245 249

2. The median value of the ordered pixel is computed as follows:

$$\cancel{0}\ \cancel{0}\ \cancel{0}\ \cancel{67}\ 141\ \cancel{173}\ \cancel{243}\ \cancel{245}\ \cancel{249}$$

The median value is computed to be 141. Then, the noisy pixel value of 67 will be replaced by the computed median value of 141.

Table 4: Noisy Matrix

249	173	141
243	67	0
245	0	0

Table 5: Denoised Matrix

249	173	141
243	141	0
245	0	0

Repeat this process for all pixels of noisy matrix using 5x5, 8x8 and 10x10 window matrix. We get the denoised image as well as denoised matrix after applying Median filter, this process will be executed for whole noisy matrix. The complete denoised matrix and image given below:

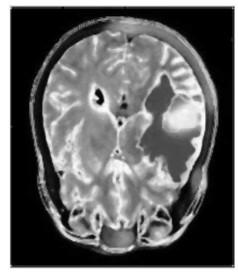

Fig No.6: Denoised Image

Table 6: Pixel Value of Denoised Image.

0	67	0	0	0
67	141	2	0	0
65	65	0	0	0
65	65	0	0	0
65	68	0	0	0

5.4 Performance Calculation

Performance calculation is a measure of quality of reconstruction of noisy compression codes. The signal in this case is the original data, and the noise is the error introduced by transmission. It is used to calculate the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

a. Mean Square Error

MSE indicates average error of the pixels throughout the image. It refers to a greater difference between the original and denoised image.

The formula for the MSE calculation [8]:

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

Let's take the 3x3 matrix of original and denoised matrix from table 1 and table 6. The Performance of filter is calculated by MSE, Put the pixel values of original and denoised matrix into expression the steps are given below:

Then we get:

$$MSE = (1/9)\ (0-2+0-0+0-0+0-0+2-0+0-0+0-0+3-0+1-0)^2$$
$$= (1/9)*(4)^2$$
$$= 1.77$$

b. Peak Signal to Noise Ratio

PSNR is most commonly used as a measure the quality of reconstruction of noisy image. It is used to calculate the ratio between the maximum possible power of a signal and the power of corrupting noise.

The PSNR is defined as [8]:

$$PSNR= 10.\log_{10} (255^2/MSE)$$

PSNR can be calculated by using the calculated MSE of original and noisy image put the MSE in the PSNR expression then we get:

$$PSNR=10.\log_{10} (255^2/MSE)$$
$$=10.\log_{10} (36737)$$
$$=10.\log_{10} (10^4)$$
$$= 40\ \%$$

c. Signal to Noise Ratio

Signal to noise ratio is sometimes referring the ratio of useful information to the corrupted or false data. The formula for the SNR calculation is given below:

SNR is defined as [8]:

$$SNR= 10.\log_{10} ((1/mxn) \sum_{i=1}^{m}\sum_{j=1}^{n} [I(i,j)]^2/MSE)$$

SNR can be calculated as:

Take the original matrix to calculate the SNR

Table 7: Original Matrix

0	0	0
0	2	0
0	3	1

Then we get:

$$SNR =10.\log_{10} ((1/9) * (2^2+3^2+1^2/1.77))$$
$$=10.\log_{10}(7.9/9)$$
$$=10.\log_{10}(10^1)$$
$$=10\ \%$$

Process will be repeated separately for next 3x3 matrix of original as well as denoised.

d. Enhancement Technique

High pass filter is a sharpening method by this we can obtain a sharp image by subtracting a lowpass filtered image from the original image [9]. Image sharpening emphasizes edges but details might be lost. Amplify input image, then subtract a lowpass image.

Sharp image = Original Image – Low Frequency (7)

Input:
Call a Denoised image 'D'.
Initialize row value.
Initialize column value.

Let us consider the 3x3 matrix from table 6 , it is a part of denoised matrix:

1. The size of matrix is 3x3
2. Execute for loop for i and j from 1 to 3
3. Calculate ip, im, jm and jp

Where ip = i+1, im = i-1, jm = j-1 and jp = j+1, So the value will be ip = 2, im = 0, jm = 0 and jp =2

4. Substitute the values in the given expression where i=1 and j=1

S(1,1) = 9*f(1,1)-1(f(1,0)+f(1,2)+f(2,1)+f(0,1)+f(0,0)+ f(2,0)+f(2,2)+f(0,2))

Put the pixel values of each coordinate.

S(1,1) = 9(0)-1(0+67+67+0+0+0+141+0)
= -275

The reason for -275 is a value that is lower than zero that is supposed to be darker than the darkest value. If we now take the mod, we get 275, which is not darker than zero. Simple way to get all negative value is 0. Hence -275 would be 0. Similarly repeat this process for all 3x3 matrix. The enhanced image is shown in figure.

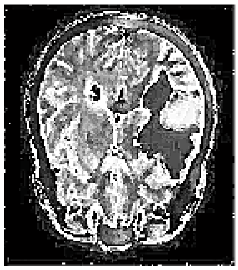

Fig No.7: Enhanced Image

VI. CONCLUSION

In this paper, we have found that median filter and high pass filter are used to improving the quality of image enhancement. It is concluded that the median filter is best for salt and pepper noise in range between 0.02 to 0.14 here we are also simulated MSE, PSNR and SNR for noisy image then high pass filter for smoothing and sharpening, it is remove the low pass frequency and enhance the quality of image. Unsharp masking is perform the edge enhancement.

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