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Enhancement in Progressive Switching Median Filter for Denoising Noise

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ABSTRACT-

In this paper, an algorithm is presented to remove Salt and Pepper noise from grayscale images. Salt and Pepper noise can corrupt the images where the corrupted pixel takes either maximum or minimum gray level. In this work, we reduce Salt and Pepper noise using Improved Progressive Switching Median Filter (IPSMF). It is implemented, and the effectiveness on denoising is evaluated by PSNR and MSE.The experimental result will show the comparison and the performance of Existing filter with improved filter to de-noise the noised image. Also the simulation result based on MATLAB will be compared with the result of ISIM and VSIM.

KEYWORDS: Salt and Pepper noise, Peak Signal to Noise Ratio(PSNR), Mean Square Error(MSE), Improved Progressive Switching Median Filter(IPSMF).

I. INTRODUCTION

Salt & Pepper Noise in the images is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. For images corrupted by salt-and-pepper noise, noisy pixels can take only the maximum or the minimum values. There are many works on the restoration of images corrupted by salt & pepper noise. The median filter was once the most popular nonlinear filter for removing salt & pepper noise because of its good denoising power and computational efficiency.However, when the noise level is over 50%, some details and edges of the original image are smeared by the filter. The image processing is an important process in every life application. Image processing is an electronic domain where in image is divided into small unit called pixel and then various operation is carried out. When an image is formed, factors such as lighting (spectra, source and intensity) and camera characteristics (sensor response, lenses) effect the appearance of the image. So, the prime factor that reduces the quality of the image is Noise. Noise hides the important details of images. There are different types of noises which corrupt the images. These noises are appeared on images in different ways: at the time of acquisition, due to noisy sensors, due to faulty scanner or due to faulty digital camera, due to transmission channel errors, due to corrupted storage media.

In image processing, the impulse noise reduction from images plays a very vital role. Impulse noise in images is present due to bit errors in transmission or induced during the signal acquisition stage. There are two types of impulse noise, like Salt and Pepper Noise and random valued noise. Salt and Pepper noise can corrupt the images where the corrupted pixel takes either maximum or minimum gray level. The removal of noise from the image is known as Denoising. Image denoising is one of the most common and important image processing operations in image and video processing applications. The important property of a good image denoising model is that, it should completely remove noise as far as possible as well as preserve edges. Traditionally there are two types of denoising models, i.e. linear filtering and non linear filtering. The main aim of the filtering is to eliminate outliers with maximum signal distortion to the recovered noise free image. Many types of linear filters removes salt and pepper noise but blur the image, the linear approaches were very popular because of its mathematical simplicity. In linear filtering denoising techniques is directly applied to the image pixel without checking the availability of noisy and non noisy pixels. The examples of linear filtering are Mean filter. The disadvantage of this filter is it will affect the quality of non noisy pixel. In the case of non linear filter, this is done by two steps first detection then filtering. First step the position of the

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noise is detected and in the second step replace the noisy pixel with calculated value. Non linear filtering techniques are implemented widely because of their superior performance in removing salt and pepper noise and also preserving fine details of image. There are many works on the restoration of images corrupted by salt and pepper noise. The median filter was once the most popular non linear filter for removing impulse noise, because of its good denoising power and computational efficiency. Median filters are known for their capability to remove impulse noise as well as preserve the edges.

II. TYPES OF FILTER

1.MEAN FILTER:- There are two types of filtering schemes namely linear filtering and nonlinear filtering. Mean filter comes under linear filtering scheme. Mean filter is also known as averaging filter. The Mean Filter applies mask over each pixel in the signal. Each of the components of the pixels comes under the mask are being averaged together to form a single pixel that's why the filter is otherwise known as average filter. Edge preserving criteria is poor in mean filter. Mean filter is defined by. Where (x1 ….. xN) is image pixel range. Mean filter is useful for removing grain noise from the photography image. As each pixel gets summed the average of the pixels in its neighborhood is found out, local variations caused by grain noise are reduced considerably by replacing it with average value.

2.MEDIAN FILTER:- Median filter is the nonlinear filter. The main idea behind the median filter is to find the median value by across the window, replacing each entry in the window with the median value of the pixel.

Median value calculation 115, 119, 120, 123, 124, 125, 126, 127, 150. Median value = 124. The pattern of neighbor's pixels is called the "window", when the window contains odd number of values in it than the median is simple: it is just the center value after all the entries in the window are sorted numerically in ascending order. But for an even number of entries, there is more than one center value; in that case the average of the two center pixel values is used. One of the major problems with the median filter is that it is relatively expensive and complex computation. For finding the median it is necessary to sort all the values in the neighborhood into numerical order and this filter relatively slow, even it is performed with fast sorting algorithms like quick sort. However the basic algorithm can be enhanced somewhat for the speed purpose.

3.PROGRESSIVE SWITCHING MEDIAN FILTER:- **:** It is a median-based filter, which works in two stages. In the first stage an impulse detection algorithm is used to generate a sequence of binary flag images. This binary flag image predicts the location of noise in the observed image. In the second stage noise filtering is applied progressively through several iterations. This filter is a very good filter for fixed valued impulse noise but for random values the performance is abysmal. The advantage of using Progressive Switching Median Filter preserves the positions of boundaries in an image, making this method useful for visual examination and measurement. The progressive switching median (PSM) filter implements a noise detection algorithm before filtering. But the disadvantage is to removes both the noise and the fine detail since it cannot tell the difference between the two. Both noise detection and filtering procedures are progressively repeated for a number of iterations. As an attempt to improve the PSM filter, an improved proposed.

4.IMPROVED PROGRESSIVE

SWITCHING MEDIAN FILTER(IPSMF):-

As an attempt to improve the PSM filter, an improved progressive switching median filter (IPSM) is proposed to enhance progressive median filter in term of its noise filtering ability. The proposed algorithm sets a limit on the number of good pixels used in determine median and mean values, and substitute impulse pixel with half of the value of the summation of median and mean value.Experimental results show that the proposed algorithm performs a better noise filtering ability as the images are highly corrupted.

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5.GAUSSIAN FILTER:- The Gaussian filtering scheme is based on the peak detection. The peak detection is based on the fact that peaks are to be impulses. The key point is that this filter corrects not only the spectral coefficient of interest, but all the amplitude spectrum coefficients within the filter window.

Some properties of Gaussian filter are:

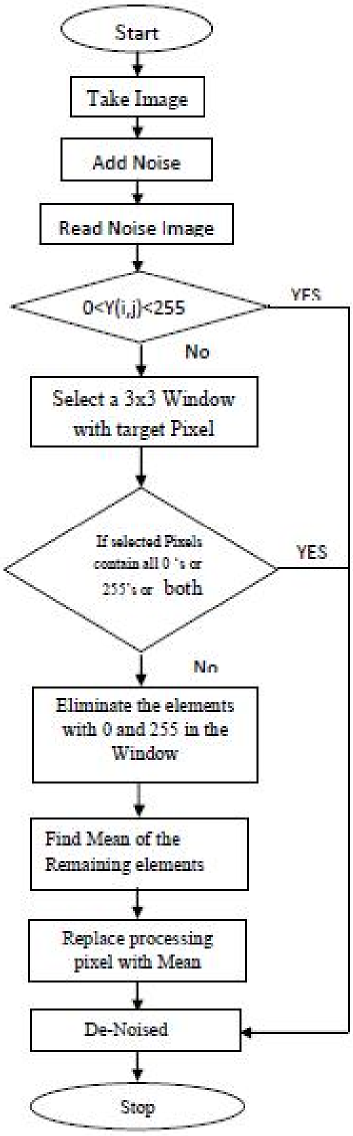
1.The weights give higher significance to pixels near the edge (reduces edge blurring).

2.They are linear low pass filters.

3.Computationally efficient (large filters are implemented using small 1D filters).

4.Rotationally symmetric (perform the same in all directions).

METHODOLOGY



FLOW CHART

ALGORITHM

Step I: Starting from the middle pixel of an image with a 3x3 initial window size. The scanning process will be done through the whole image from middle to the upper left, upper right, lower left and lower right corners of the image.

Step 2: Calculate median from the pixel values of the current window except values of O and 255.

Step 3: This step checks the following conditions: -

(a) If the median is noise-free (i.e. at least one noise-free pixel remains in window) then replace the center pixel with the median and go to Step 5.

(b) If the median is noisy (that means no noise-free pixel is found in window) then increase the window size by one pixel at each of its four sides and perform the Step 2 up to maximum window size.

(c) If the maximum window size (5x5) is reached and still no median is found, then go to next step (Step 4).

Step 4: This step considers the last processed pixel (which was processed just before the current center pixel). As the scanning starts from the middle pixel, it

is more likely of getting last processed pixel within the image boundary. If the last proceed pixel is not 0 or 255 then replace the current center pixel with that processed pixel.

Step 5: Slide the window to the next pixel.

III. OBJECTIVES

Our objectives includes the following:-

Step 1:Select an image on which we want to work for noise filtering.

Step 2:Image represent by pixels, so some pixels are good or some are bad due to some problem during capturing. Mean filter based on Linear De-noising never check about quality of pixels. It works only in step that is Filtering. So filter based on Median is used in our research work that detects corrupted pixels and then filter.

Step 3: Progressive Switching Median Filter based on Non-linear de-noising is implement on that noisy image and get result.

Step 4: This Filter has a disadvantage that it removes both the noise and the fine detail pixel since it cannot tell the difference between the two. It can tell only median level pixel.

Step 5: The pixel in fine quality is useful for us, so to overcome this problem we propose a new filter.

Step 6: The proposed filter sets a limit of pixel quality and the pixels higher that limit never change but noisy pixels improved by number of iterations.

Step 7: Result of improved filter compared with existing pixels and analysis of comparison provide us a conclusion of our research work.

IV. SIMULATION AND PERFORMANCE ANALYSIS

CASE 1:- WITH MATLAB

This method has been implemented using Matlab as the simulation tool. The proposed filter is tested with Image 'CAMERAMAN.tif' of size 250 x 250. The image is corrupted by Salt and Pepper noise at various noise densities and performance is measured using the parameters such as Peak-Signal-to-Noise Ratio (PSNR), Mean Square Error (MSE).

The parameters used to define the performance are:

- **Peak Signal-to-Noise Ratio (PSNR):**

PSNR = 20 log10 (255∕RMSE)

…..where Root Mean square error (MSE)

- **Mean Square Error (MSE) :**

MSE = √1∕MN Σ (Yij-Xij)2 i, j

The simulation results and data are shown below:

In figure 1 a in built cameraman image available in matlab software has been loaded in matlab workspace and the data type of image has been converted to double type due to addition of noise intensities.

figure 1- original image

Figure 2 is a demonstration of noise which is introduced in the original image. When salt and pepper noise is added the entire image space is filled with intensity values 0 or 255. This means pepper and salt respectively. The image in figure 2 has been shown with 50% noise meaning that approximately half of the pixels are actually corrupt now.

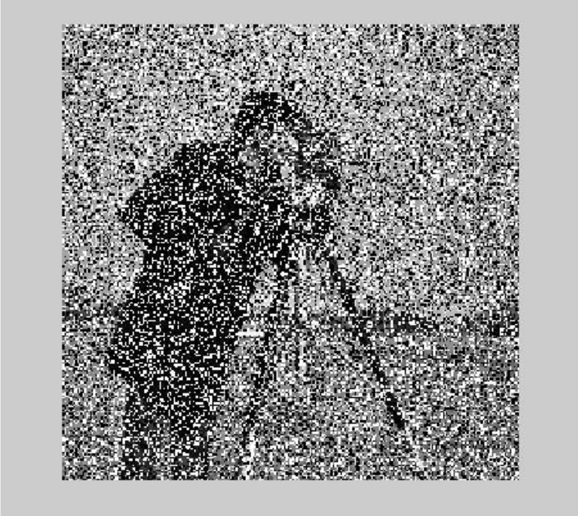


figure 2- image with 50% noise

In figure 3 the result seen is a filtering effect introduced in this image that is available readily namely progressive switching median filtering. Due to this filtering noise has reduced but the quality of image remains unsatisfactorily.

Figure 3- denoised image with psm filter

In figure 4 a highly drastic change can be seen as a lot of change could be seen in the existing image for the purpose of filtering. The improvements made in the complete image is available in the form of 50% noise available. But now when image quality remains suspended in progressive switching median filter its efficiency is improved by applying a better filter. This better filter is nothing but a two stage filtering of image using psm filter in the first image and low pass Gaussian filter in the second stage.

Figure 4- denoised image with improved psm filter

After concluding the results on cameraman image it is necessary that some modification work could be made more presentable by adding another table where image noise is being added with the original image so percentage noise is one point the other point is the performance evaluation of the modification technique using peak signal to noise ratio and mean square error. As per the formulation of formula stated at the beginning both terms are reciprocal to one another. If psnr increases then mse increases.

PERFORMANCE ANALYSIS

1. **MEAN SQUARE ERROR**
2. **PEAK SIGNAL TO NOISE RATIO**

NOISE LEVEL	PSM FILTER VALUE	IMPROVED PSM FILTER VALUE
10%	27.7040	28.2234
20%	25.9289	26.3476
30%	23.3906	24.8467
40%	21.0970	22.6880
50%	18.1642	20.2267
60%	13.8232	17.2921
70%	11.5963	11.0782
80%	9.6791	9.1715

Table 1. PSNR and MSE for percentage noise added

In this table a good amount of noise is added in the cameraman image as the table 1 shows noise addition of range 10% to 80%. In this paper two parameters psnr and mse are seen. If 10% noise is added psnr for psm filter is 27dB similarly for improved psm is 26 dB. At 50% noise psm shows 18dBs whereas IPSM shows 20dB. Similalr when noise is added to 80% then PSM snr is approximately9.6 dB wheras Improved PSM is approximately 9.17 dB. It is important to notice that Improved psm performs better that PSM and the results are good at this level but at high density of noise both psm and improved psm are at the same level of performance parameters psnr and mse.

CASE 2:- WITH MATLAB AND MODELSIM

As MATLAB has proved a lot using image denoising now the turn is for Verilog HDL to show case the project, though image demonstration is not feasible but still Verilog **HDL has** capability to show some good sort of results. In this research paper ModelSim in used in link with MATLAB using MATLAB HDL verifier, however the results are waveforms of pixel values that are most importantly measured. When considering figure 5 image input to modelsim and desing code of Verilog HDL has shown a few waveforms of interests. Here applied input forced in 8010H which is then checked on the design code used in this regard and MATLAB as well.

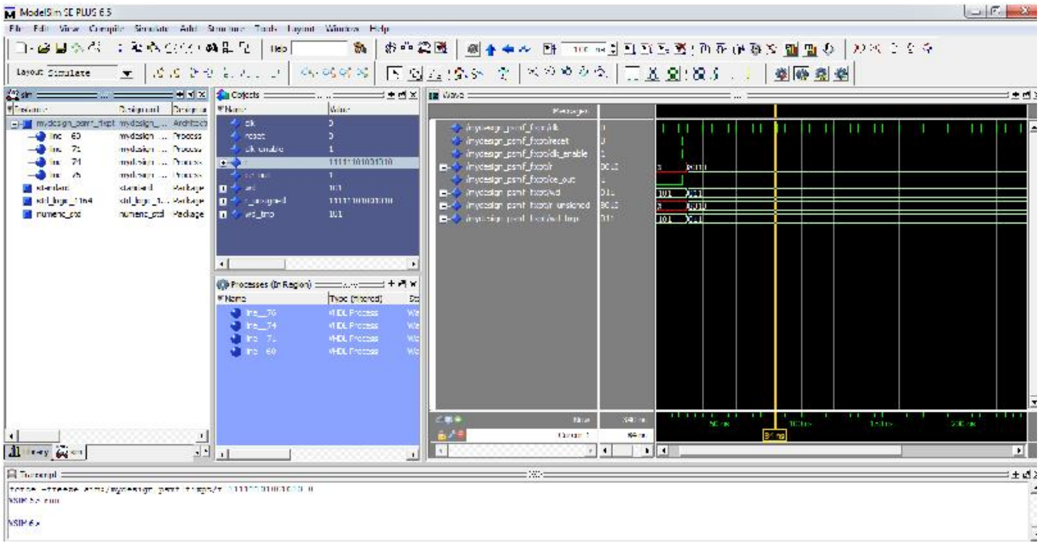


Figure 5- modelsim output signals evaluated on forced signal through modelsim

Figure 6 is modelsim output waveforms at some point the results are important as they highlighted using yellow line on top of the waveform screen. Now, applied input is 16202 in hexadecimal and output is calculated on the window wd.

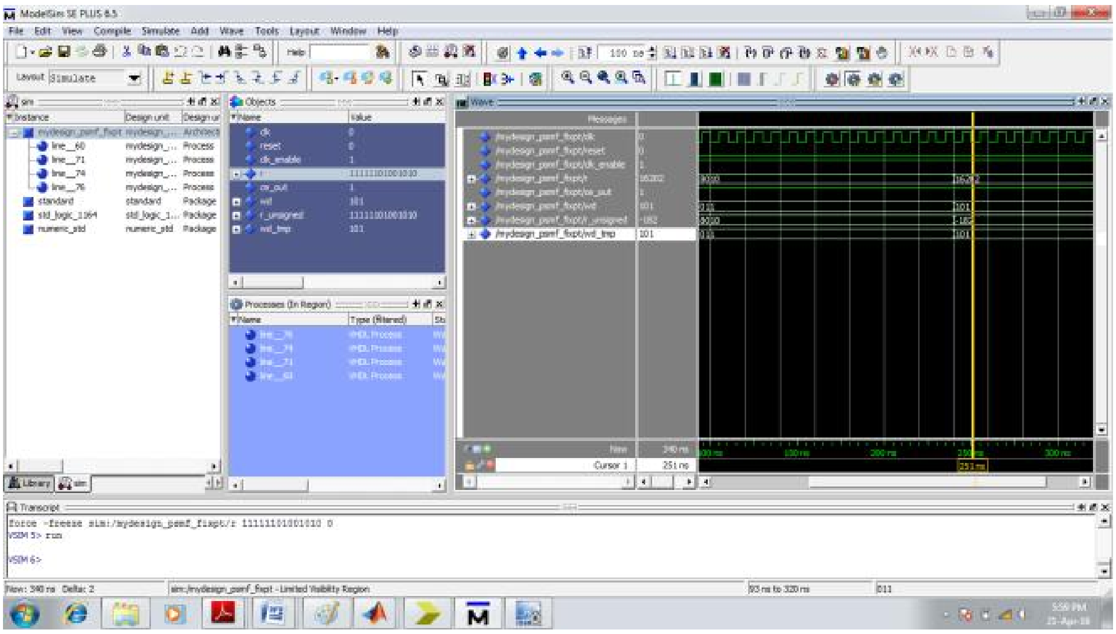


Figure 6- modelsom output signals evaluated on forced signal through modelsim

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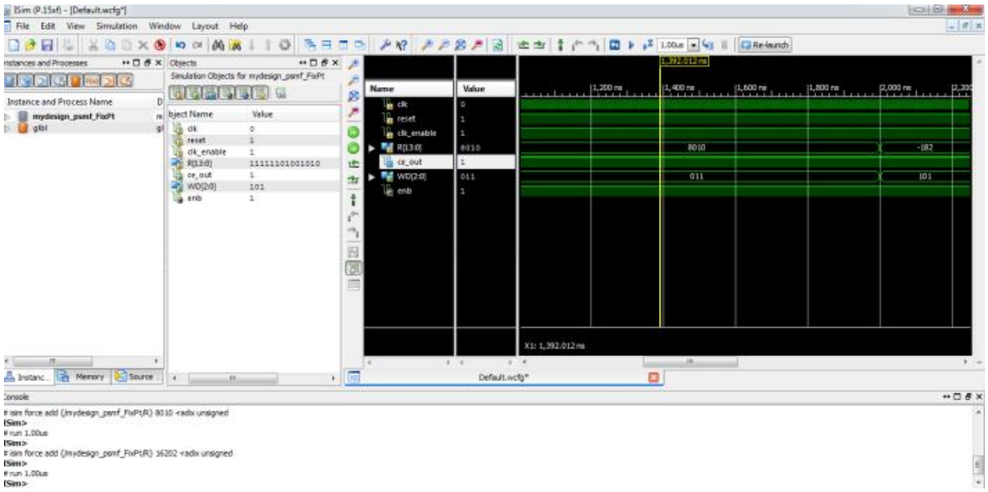
CASE 3:- WITH XILINX ISE



In figure 7 Another simulator is used which is XILINX ISE and the results are again checked only using ISIM simulator here resulst are evalauated using a force input of 8010H. It is found that bothe with MALAB and Modelsim are same.

Figure 7- Xilinx output

Applied input is 8010 in hexadecimal and output is calculated on the window. In figure 8 final output using ISIM simulator has been done.

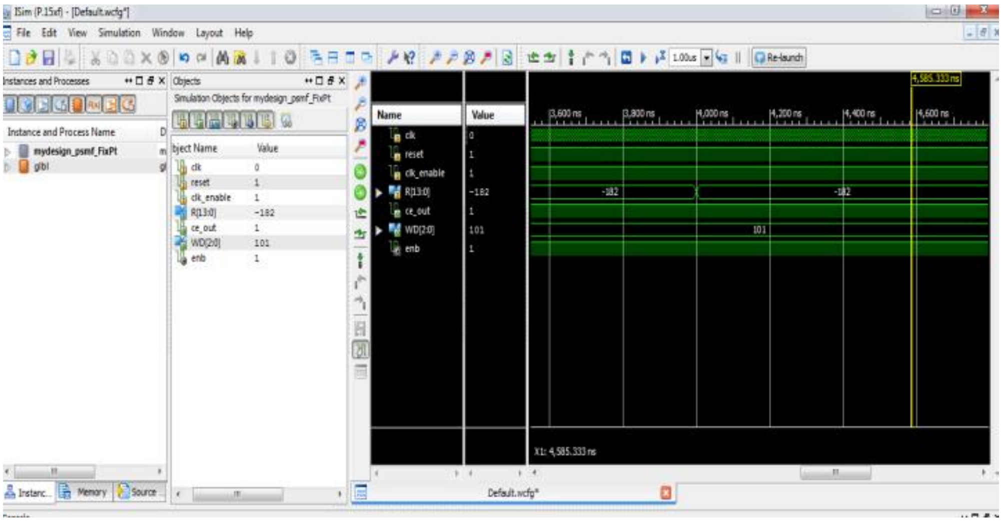


Figure 8- Xilinx output

V. CONCLUSION

It is conclude that noise from an image can be removed using some denoising filters. Median filters are used for this noise reduction. Progressive Switching Median Filter is one of them which have a drawback that it uses number of iterations many times for each type pixel like good or bad. So it is improved in term of filtering ability. So in this research work we fix a limit of pixel quality. Filtering detect pixels that has lower quality than that fixed value. So numbers of iterations are less as compared to existing progressive switching filtering. Also the waveform of Modelsim and Xilinx are compared on the negative edge clock having clock enable and the results are evaluated. The percentage noise removal and noise effects are same using MATLAB only and with MATLAB and modelsim only.

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