Discrete Wavelet Transform Method For The Reduction Of Computation Time To Denoise Image Corrupted By Salt And Pepper Noise

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Abstract— **In image processing, restoration and noise reduction are expected to improve the quality of the image and the performance of quantitative image analysis. Adaptive median filtering techniques and the non-local means filtering algorithm are used to denoise image, corrupted by salt and pepper noise. Adaptive median filtering involves a two stage process, when the number of computations is very high and hence the simulation time increases with increase in the size of the corrupted image. DWT (Discrete Wavelet Transform) Denoising which exhibits good performance both in denoising and in restoration can be easily and effectively parallelized to exploit the full power of multi-core processor performance. The proposed Wavelet Denoising implementation based on the Fast Flow library achieves both close-to-ideal speedup and very good wall-clock execution figures. In Experimental result, PSNR provides better results when compared with the NLM.**

Index Terms— Adaptive Median Filter, Salt and Pepper Noise, Median Filter, Principal Component Analysis Filter, Discrete Wavelet Transform(DWT), Peak Signal To Noise Ratio(PSNR).

I INTRODUCTION

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics associated with that image [7] [8]. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps:

- Importing the image via image acquisition tools.
- Analysing and manipulating the image.
- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analog and digital image processing [4]. Analog image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display information extraction [2]. Images may be two-dimensional, such as a photograph, screen display, and as well as a three-dimensional, such as a statue. They may be captured by optical devices such as cameras, mirrors, lenses, telescopes, microscopes etc. and natural objects and phenomena, such as the human eye or water surfaces [14]. The word image is also used in the broader sense of any two-dimensional figure such as a map, a graph, a pie chart, or a painting. In this wider sense, images can also be rendered manually, such as by drawing, the art of painting, carving, rendered automatically by printing or computer graphics technology, or developed by a combination of methods, especially in a pseudo-photograph. A Volatile image is one that exists only for a short period of time [11]. A fixed image, also called a hard copy, is one that has been recorded on a material object, such as paper or textile by photography or any other digital process [1] [6].

II RELATED WORK

In the literature, Impulse noise is caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware, or transmission in a noisy channel. Two common types of impulse noise are the salt-and-pepper noise and the random-valued noise [12] [9]. For images corrupted by salt-and pepper noise (respectively random-valued noise), the noisy pixels can take only the maximum and the minimum values (respectively any random value) in the dynamic range. There are many works on the restoration of images corrupted by impulse noise [9]. The median filter was once the most popular nonlinear filter for removing impulse noise, because of its good denoising power and computational efficiency [15]. However, when the noise level is over 70%, some details and edges of the original image are smeared by the filter.

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III PROPOSED METHODOLOGY

Salt and pepper noise [7], which may be caused by malfunctioning pixels in camera sensors, faulty memory locations in hardware or transmission in a noisy channel [8][14]. The original test image is corrupted with simulated salt and pepper noise with different noise variance ranging from 0.1 to 0.3. In the proposed denoising approach, the noisy image is first applied to a DWT (Discrete Wavelet Transform) filter. The maximum allowed size of the window of the DWT (Discrete Wavelet Transform) filter is taken to be 5X5 for effective filtering. The choice of maximum allowed window size depends on the application but a reasonable value was computed by experimenting with various sizes of standard median filter. In the second stage the resultant image is subjected to NL-means filtering technique [15].

Advantages

- ❖ It will allow better distinguish between real motion and image noise.
- ❖ It results in a possibility to store more data evidence on hard drive.
- ❖ The system will deliver a cleaner signal, providing for up to 90%
- ❖ Less computation time is required when denoising.
- ❖ Using low-discrepancy sequences is a faster rate of convergence.

IV EXPERIMENTAL RESULTS

Simulation Intensive simulations were dispensed victimization many monochrome pictures, that a 256x256 "pout.png" image is chosen for demonstration. The test image is corrupted by fixed value salt and pepper noise with noise variance varying from 0.1 to 0.9. The output of the proposed technique is compared with different standard methods such as Median filters MF (3X3) and MF (5X5), DWT (Discrete Wavelet Transform) filter AMF (7X7). The results are quantified using the following well defined parameters such
as a) Mean Average Error (MAE) b) Mean Square Error (MSE) c) Peak Signal to Noise Ratio (PSNR).

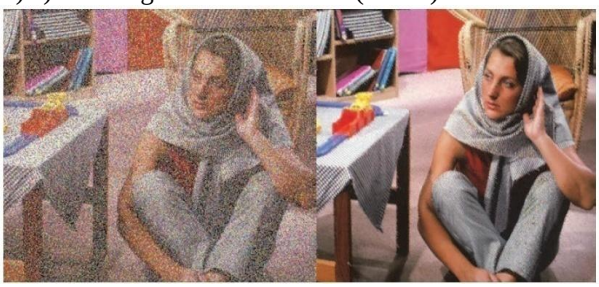

Figure 1: Results obtained for the noise level (30%) corrupted for the 512x512 Barbara color image and its denoised image.

Intensive simulations were carried out using two monochrome images (Figure1), from which a 512 **x** 512. "Barbara.png" image is chosen for demonstration. The test image is corrupted by fixed value salt and pepper noise with noise variance varying from 0.1 to 0.3. The output of the proposed technique is compared with different standard methods such as Median filters MF (3X3) and MF (5X5), DWT (Discrete Wavelet Transform) filter AMF (7X7). Figure 2 represents the graphic analysis of performance matrices for Barbara bitmap image. The results are quantified using the following well defined parameters such as,

A) Mean Average Error (MAE)

$$MAE = \frac{1}{mn} \sum i \sum j \, |r_{ij} - x_{ij}|$$

where r_{ij} and x_{ij} denote the pixel values of the restored image and the original image respectively and m x n is the size of the image. I and j denote the original and filtered image [13].

B) Mean Square Error (MSE)

$$MSE = \frac{1}{mn} \sum_{i=1}^{M} \sum_{j=1}^{N} \left| r_{ij} - x_{ij} \right|$$

where M and N are the total number of pixels in the horizontal and the vertical dimensions of the image. R_{ij} and x_{ij} denote the pixel values of the restored image and the original image respectively and m x n is the size of the image. I and j denote the original and filtered image [14].

C) Signal to Mean Square Error(S/MSE)

$$PSNR = 10.\log_{10} \frac{MAX_I^2}{MSE}$$

$$= 20.\log_{10} \frac{MAX_I}{\sqrt{MSE}}$$

$$= 20.\log_{10}(MAX_I) - 10.\log_{10}(MSE)$$

The Proposed Method performs best in terms of the peak signal-to noise ratio (PSNR). Experimental results obtained in Table 1, show that at higher noise variance the proposed method DWT denoising restores the original image much better than standard non-linear median-based filter and DWT (Discrete Wavelet Transform) filter.

Table 1: Performance matrices for noisy & denoised "barbara.png" image using proposed method

Variance	Image type	MAE	MSE	SNR	PSNR
0.1	Noisy	0.048	0.033	7.9367	62.930
	Denoised	0.016	0.008	22.882	78.915
0.2	Noisy	0.097	0.066	5.6993	59.930
	Denoised	0.022	0.001	21.143	77.196
0.3	Noisy	0.150	0.103	4.4873	57.988
	Denoised	0.029	0.002	19.196	75.262

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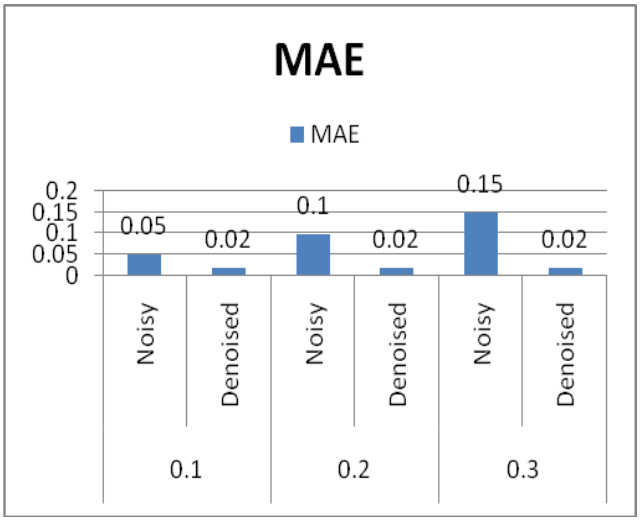

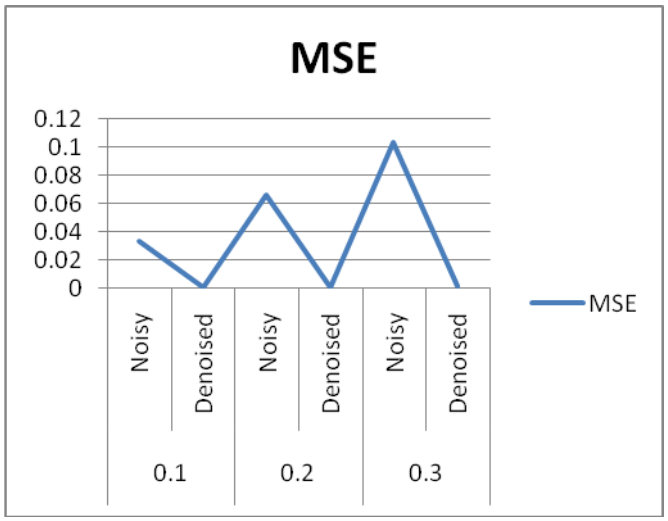

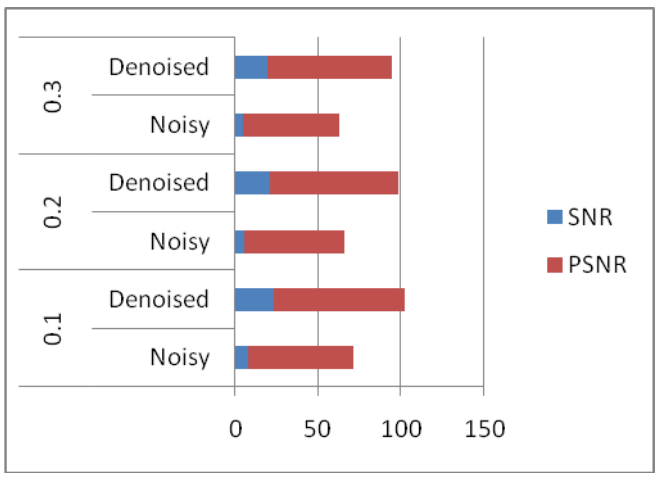

Figure 2 : Graphical analysis of performance matrices for "barbara.png" image

V CONCLUSION AND FUTURE WORK

The present work proposes Discrete Wavelet Transform method for filtering the salt and pepper noise affected image. For lower values of noise variance, the existing filters like median filter and adaptive median filter can denoise salt and pepper noise, but fail to remove noise effectively as the noise variance increase. The present work proposes a method to handle salt and pepper noise even at higher variances. In addition to denoising it reduces the computational complexity when the noise in the image is increased. Experimental result of proposed system shows better result when compare with existing system. The problem of estimating a discontinuous surface from noisy data is not dealt in present work. The procedure need to be explored further that can therefore remove noise correctly in continuity regions of the surface, and preserve discontinuities at the same time. In future, the present work can be explored for identifying different noises and preserves the edge information while denoising. Experimental results are obtained to show the feasibility of the proposed approach. These results are also compared to other filters by numerical measures and visual inspection.

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