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Performance investigation of TDBLMS Adaptive Filter for Noise cancellation

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Abstract — *Generally, images can be corrupted by different characteristic noises simultaneously, we cannot obtain satisfactory filtering result if only using single filter such as average filter or median filter. Therefore, in this paper a new Adaptive filter algorithm is proposed for filtering the image corrupted by difference noises. Firstly, we construct adaptive structure using neighborhood contrast measure; secondly, divide the image into smoothness, edge and unconfirmed regions based on the adaptive structure; then, adopt corresponding filter for different regions. The algorithm does not need a priori knowledge of images and noises. Image denoising involves the manipulation of the image data to produce a visually high quality image. Different noise models including additive and multiplicative types are used. They include Gaussian noise, salt and pepper noise and speckle noise. Selection of the denoising algorithm is application dependent. Hence, it is necessary to have knowledge about the noise present in the image so as to select the appropriate denoising algorithm.*

Keywords- *Denoising Algorithm, Adaptive Filter, Mammography Images.*

I. INTRODUCTION

A very large portion of digital image processing is devoted to image denoising. This includes research in algorithm development and routine goal oriented image processing. Image denoising is the removal or reduction of degradations that are incurred while the image is being obtained. Degradation comes from blurring as well as noise due to electronic and photometric sources.

1.1 Image Denoising

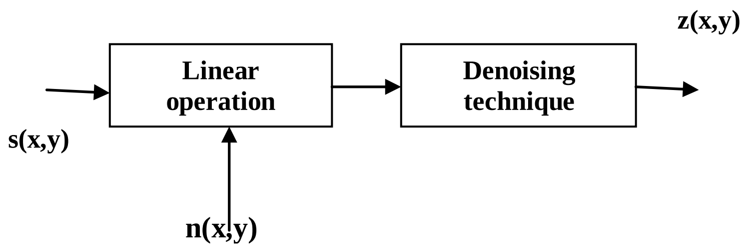

Figure 1.1 Image Denoising concept

The image *s*(*x*,*y*) is blurred by a linear operation and noise *n*(*x*,*y*) is added to form the degraded image *w*(*x*,*y*). This is convolved with the restoration procedure *g*(*x*,*y*) to produce the restored image *z*(*x*,*y*).

The "Linear operation" shown in Figure 1.1 is the addition or multiplication of the noise *n*(*x*,*y*) to the signal *s*(*x*,*y*). Once the corrupted image *w*(*x*,*y*) is obtained, it is subjected to the denoising technique to get the denoised image *z*(*x*,*y*) [1]. The point of focus in this thesis is comparing and contrasting several "denoising techniques".

1.2 Adaptive Filter

Adaptive filtering can be considered as a process in which the parameters used for the processing of signals changes according to some criterion. Usually the criterion is the estimated mean squared error or the correlation . The adaptive filters are time-varying since their parameters are continually changing in order to meet a performance requirement. In this sense, an adaptive filter can be interpreted as a filter that performs the approximation step on-line. Usually the definition of the performance criterion requires the existence of a reference signal that is usually hidden in the approximation step of fixed-filter design.

The general set up of adaptive filtering environment [2,3] is shown in Fig. 1.2, where k is the iteration number, x(k) denotes the input signal, y(k) is the adaptive filter output, and d(k) defines the desired signal. The error signal e (k) is calculated as d (k)- y (k). The error is then used to form a performance function or objective function that is required by the adaptation algorithm in order to determine the appropriate updating of the filter coefficients. The minimization of the objective function implies that the adaptive filter output signal is matching the desired signal in some sense.

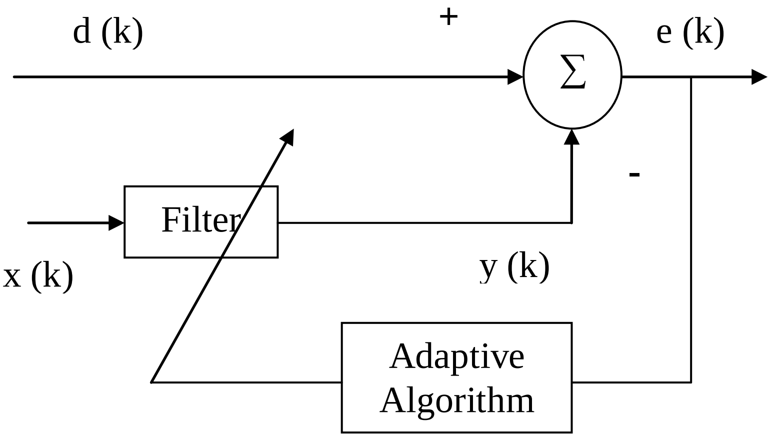

Figure 1.2 Adaptive Filter

II. LITERATURE SURVEY

Median filter has better resolved the deficiency of linear filter, and it can better preserve image details and also efficient to the noises that are far from Gaussian noise and that are not completely independent of useful signals. However, standard median filter may damage or lose details such as edges and corners which are smaller, compared to filter window size. If more details are to be preserved, filter window size should be smaller, but the filter capability will be reduced. If better filtering result is to be obtained, the filter window size should be larger, yet many details will be lost [4, 5].

The expansion of window size in the AMF is determined by the criterion if the median is a noisy pixel or not. This criterion is not appropriate when the noise density is moderate or high. Second, the pixels processed by the AMF are reused in the filtering of AMF. This doing degrades the visual quality of restored image [6]. A New Adaptive Robust Statistics Estimation Based Filter to remove low to high-density salt and pepper noise with edge preservation in digital images and videos was proposed by [7]. This filter performs well for both gray scale and colour images. For lower noise density up to 30% almost all the algorithms perform equally well in removing the salt and pepper noise completely with edge preservation. For noise densities above 50%, the standard algorithms fail to remove the salt and pepper noise complete.

III. SIMULATION RESULTS

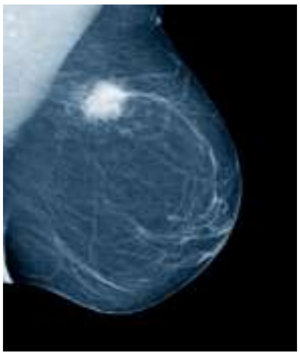

Figure 3.1 Original Image

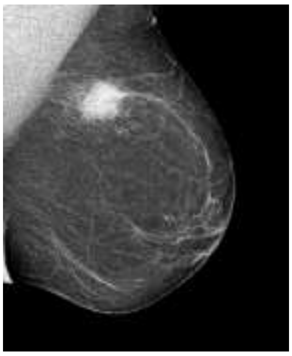

Figure 3.2 a) Image with Poisson Noise

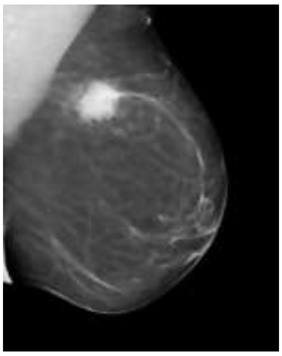

Figure 3.2 b) Restored Image using Adaptive Filter

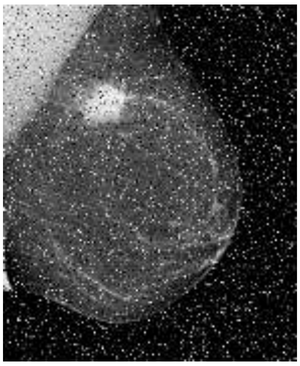

Figure 3.3 a) Image with Salt and Pepper Noise

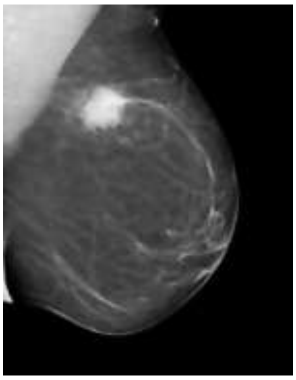

Figure 3.3 b) Restored Image using Adaptive Filter

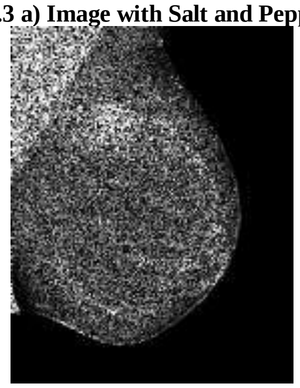

Figure 3.4 a) Image with Gaussian Noise

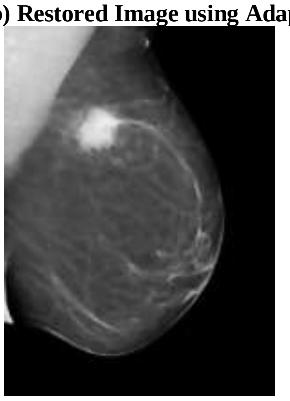

Figure 3.2 b) Restored Image using Adaptive Filter

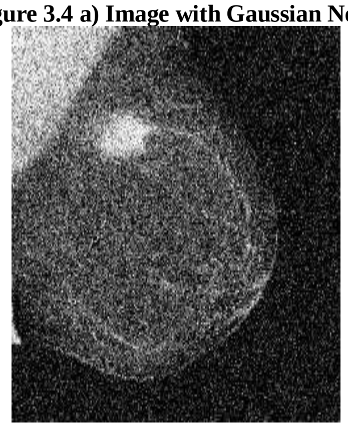

Figure 3.2 a) Image with Poisson Noise

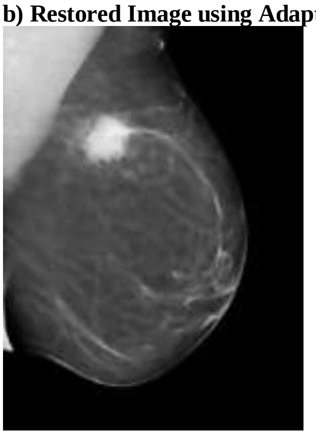

Figure 3.2 b) Restored Image using Adaptive Filter

Type of Noise	PSNR (in dB)	Error
Poisson	30.7628	7.3858
Salt & Pepper	14.1629	49.9339
Speckle	12.7718	58.6069
Gaussian	14.6094	47.4317

IV CONCLUSION

In this paper an efficient method based on local adaptive filter is presented. First an artificial signal is constructed from noisy image. Then adaptive filter is applied to reducing noise. This method is as efficient and is faster than median filter that so the simulation time is reduced. One problem in working with adaptive filter is that a reference signal is needed while in practice just noisy signal is available. In future works we are going to use TDBLMS to overcome this problem.

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