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Thresholding Based Noise Suppression in Ultrasound Images Using Wavelets

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Abstract
In today's era of technology, imaging is widely used in all fields ranging from multimedia, communication to science. Images occupy important place and as per need new devices. Different methods of imaging have been developed and optimized for diverse applications. In vicinity of electric and electronic devices, images are often affected by noise that degrades the quality and deteriorates the information contained. The proposed method works well with different threshold level and the level of decomposition. The main aim of image de-noising techniques is to remove noise while retaining as much as possible the important detail features. At the end we will discuss how de-noising techniques can be optimized using the thresholding parameter and varying the levels of decomposition. We have to optimize the value of threshold and level of decomposition in a way such that the texture in the image remains conserved.
Keywords- De-noising, wavelets, image processing, ultrasound, Speckle

I. INTRODUCTION

Ultrasound imaging is being used in the field of medical sciences. It is used for imaging soft tissues in organs like liver, kidney, spleen, uterus, heart, brain etc. Ultra-sonography is one of the most powerful techniques for imaging organs and soft tissues in human body. This is because it is inexpensive, harmless to human body, portable and non–invasive. The basic drawback of ultrasound images is that they are contaminated with multiplicative noise called speckle [1]. Speckle noise is a random mottling of the image with bright and dark spots, which obscures fine details and degrades the detectability of low-contrast lesions [2,3]. The source of image quality degradation in ultrasound image is speckle noise. Speckle degrades the resolution and the object detectability. Image de-noising still remains the challenge for researchers because noise removal causes blurring of the images [4-6]. Image analysis deals with processing of images using computer with the goal of finding what details are present in the image. Noise is undesired information that contaminates the image. It can happen due to certain spikes in the signal that are due to electrical fluctuations and disturbances that rise while the image is being taken. What noise does is that it makes the image have more extraneous and irrelevant information which needs to be reduced for faster and accurate processing. In medical imaging, particularly diagnosis where texture of the object in image should be clearly visible and not messy, noise has its adverse effects on detail. Diagnose of any anomaly solely depends on quality of image produced. Texture depends on how noise is filtered from the image. If the texture is degraded, the image cannot be used for diagnosis. Texture should be considered while de-noising the images. The proposed de-noising method for ultrasound images is using wavelets. In ultrasound images, the noise can restrain information which is valuable for the general practitioner. As a result medical images have become inconsistent and it is therefore necessary to operate case to case.

II. METHODOLOGY

In medical images like x-ray, ultrasound etc. information depends on clarity of texture. Wavelets are used to remove noise from images by smoothing. Texture loss occurs due to smoothing. If the medical image is degraded, then diagnosis becomes difficult. Loss of texture from the image makes it unfit for diagnosis. Wavelet transform has become an indispensable image processing tool for a variety of applications including compression and de-noising [7-9]. Image de-noising is done based on wavelet coefficient thresholding, also called wavelet shrinkage. The majority of wavelets filters have been used for de-noising in a variety of medical imaging applications. A basic procedure is to compute the discrete wavelet transform of the image followed by wavelet coefficients based noise suppression and finally performing the inverse wavelet transform DWT to reconstruct the de-noised image. The threshold has an important role in the de-noising of images. In image processing, thresholding is used to split an image into smaller segments or junks, using at least one color or grayscale value to define their boundary. It's often the initial step in a sequence of image-processing operations. Figure-1 shows the basic operation of de-noising process.

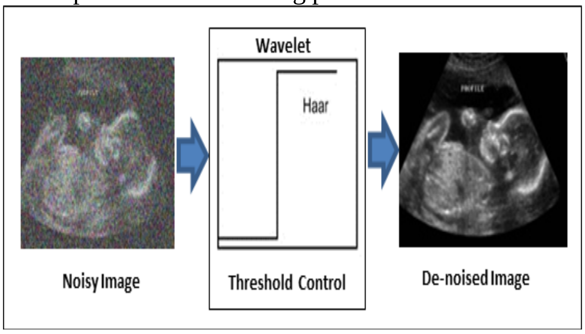

Figure 1.Wavelet bases ultrasound image de-noising

Wavelet de-noising removes the noise present in the image while preserving the image characteristics regardless of its frequency content [10,11]. Wavelets preserve visual quality and also maintain the diagnostically significant details of ultrasound images. The purpose of de-noising is to remove the noise while retaining the edges and other detailed features as much as possible. The purpose of image de-noising is to estimate the original image form the noisy data. Noise in the image causes two negative effects, firstly it degrades the image quality and secondly, it conceals important information required for accurate diagnosis. With improved health care policy and increasing number of available medical equipment, the number of radiological medical procedures is increasing considerably. Effectiveness of good quality imaging is important for further medical decision making and can reduce unnecessary procedures. Therefore we have to find out optimal values for reconstruction of degraded images so that images can be processed as per requirement. The de-noising technique should not cause loss of edge information and other important details which render it unfit for diagnosis. The wavelet approach is used for enhancement. Enhancement involves smoothing speckles at homogenous areas and preserving thin details and edges. Applications of these methods on ultrasonic images provide a significant improvement of speckle reduction. Similarly if image is decomposed at large levels, details are lost. Hence image should be de-noised in such a manner that degradation does not occur and optimum de-noised image is obtained. The parameters have to be optimized in such a way that image can be used for processing.

III. RESULTS

Wavelet families have great impact on the noise levels. Here artificially noise is added to the image for processing. When applying *haar* wavelets it causes blocking effect on the images reconstructed after de-noising. Processing a noisy image with wavelets at higher decomposition levels, changing the type of wavelet and again processing, the blocking effect is eliminated but another effect called ringing is introduced in the de-noised image. This ringing effect is observed clearly with *sym6* wavelet implementation. By adjusting the threshold levels in wavelet operation the output of the process provides acceptable results at particular values only. In course of de-noising when the threshold levels are adjusted this ringing effect also disappeared.

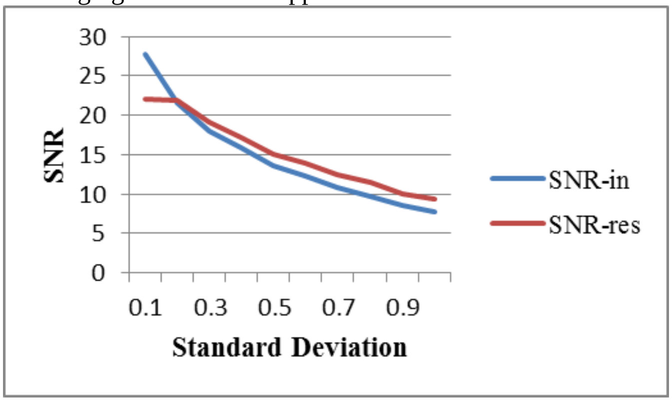

Figure 2.*Graph of standard deviation and SNR for K=1*

A graph in figure-2 shows the SNR values for input (noisy) and resulting de-noised image when varying the standard deviation of noise in image. Another plot in figure-3 shows the PSNR's with different thresholding levels in image de-noising process.

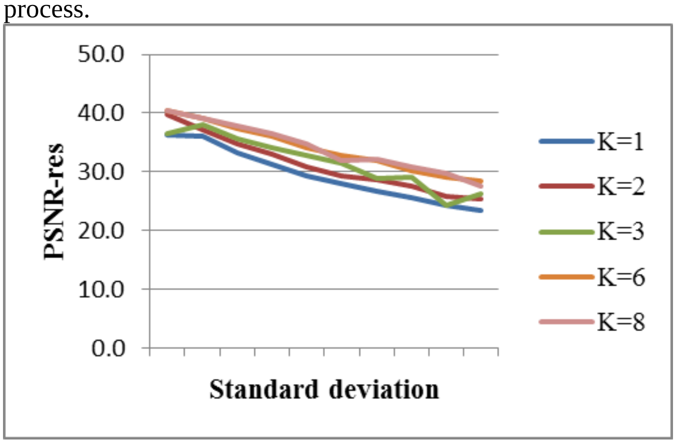

Figure 3.*Graph of standard deviation and PSNR-res*

In this particular case comparison shows that the optimum value of PSNR-res over the minimum and maximum range of noise is for K=8. Thresholding should not be used when there is strongly varying illumination across the image and when objects are hardly distinguishable. Images get degraded as level of threshold increases. The approach that we have followed uses ultrasound image for de-noising. An arbitrary noise is added for which we can select the standard deviation.

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