

Reduction of Speckle Noise in Medical Images

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Abstract - To scan different human organs magnetic imaging devices are used such as Ultrasound, magnetic resonance image, X-ray etc. Using these devices we can get medical images which can be used to detect diseases. However, these medical images are often corrupted by noise. Noise is present in medical images during acquisition, coding, transmission and processing steps. Medical images are oftentimes affected by speckle noise. We need to remove the speckle noise in order to utilize medical images accurately. In order to extract essential information from medical images, de-noising must be done. In this report, we have extensively studied various existing methods to reduce speckle noise and come up with a very application specific method that gave the best results compared to other existing methods. Stationary wavelet transform is used to de-noise the image but it may cause losing information such as edges and contrast. So, a dynamic technique which can process image and noise parameters separately is needed. Therefore, the proposed method uses de-noising and edge enhancing technique separately on noisy image. After this process, image fusion is used to combine these images and a final de-noised image is obtained. The processed image has been found to be satisfactory to diagnose medical conditions better than existing versions.

keywords - Speckle Noise, Medical Images, Image Processing

II. INTRODUCTION

Definition of Image

Before going into noise in image, let's talk about image itself. Image is a visual representation of something. In information technology this term has many uses. An image is a picture that has been created or copied and stored in an electronic format. It can be described in terms of vector graphics or raster graphics. An image stored in raster form is called a bitmap.

Noise in image

Image noise is a random variation of noise or color information in images. It can be produced by sensor and circuitry of a scanner or digital camera. Noise is present in digital images, it can happen during acquisition, transmission and processing steps. The noisy image can be modeled as follows - $g(x,y)=f(x,y)+n(x,y)$ where $f(x,y)$ is the original image, $n(x,y)$ is the noisy term and $g(x,y)$ is the resulting noisy pixel. Noise is present in an image either in additive form or multiplicative form. There are many kinds of noises like Gaussian noise, speckle noise, salt and pepper noise, Poisson noise etc.

Gaussian Noise

It is caused by random fluctuations in the signal. Gaussian noise is a statistical noise where the probability density function is equal to that of normal distribution, which is also known as Gaussian distribution. Gaussian noise can be reduced by spatial filters. Spatial filtering techniques for noise removal are mean filter, median filter and Gaussian smoothing.

Salt and Pepper noise

Also known as shot noise or impulse noise is caused by faulty memory locations, Malfunctioning pixel elements in camera sensors or synchronizing errors in image Digitizing or transmission. It can be seen as randomly scattered black and white pixels over an image.

Speckle Noise

Speckle noise can be modeled by random values multiplied by pixel values of an Image, so it is also known as multiplicative noise. It can be found in ultrasound Images, satellite images and radar applications.

Poisson Noise

It is caused when the photons sensed by the sensor is not enough to provide detectable Statistical information. Magnitude of Poisson noise increases with the average magnitude of current or intensity of Noise.

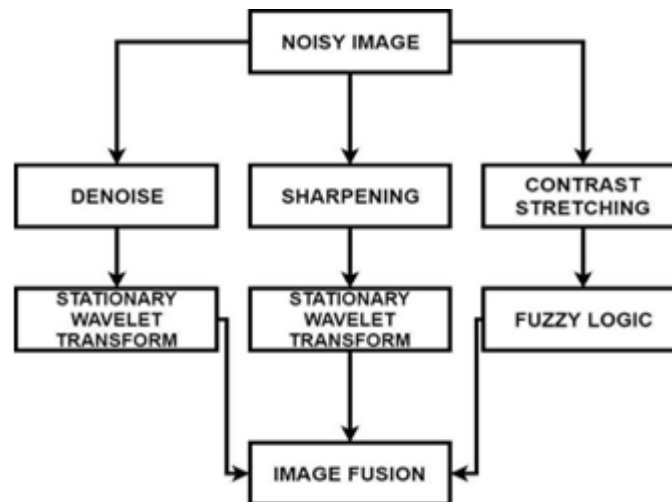
III. PROPOSED SOLUTION

We propose a method where the speckle noise can be reduced from medical images using stationary wavelet transform and fuzzy logic. Stationary wavelet transform usually decomposes an image into high frequency and low frequency approximations and a threshold is applied on high frequency details to reduce the noise in the image simultaneously pre-serving the high frequency details like edges. At this stage speckle noise could be removed from the images but the image could lose edges and contrast information.

In the proposed algorithm the proposed technique not only reduces the speckle but also preserves edges and the contrast information of the image by using three techniques on the noisy image separately, and they are threshold for the noise reduction and wavelet transform is used for the sharpening of the image and fuzzy logic for contrast stretching of the noisy image. In the last step all the three enhanced images are combined by image fusion in transfer domain.

III. IMPLEMENTATION

The noises that are added to the image to be captured, reduce the quality of the image. Since our project utilizes UV rays for image capturing, it's much more complicated than capturing a regular photo. Human error, sensor imperfections, sensor sensitivity among other things add to the noise of the image. Different types of noises such as additive and multiplicative noise affect the actual image so much that diagnosis using the noisy image becomes impossible. So, we have followed a systematic approach to solve this problem.



In image we added the noise to study its characteristics in the hope of finding a solution to it. We added Poisson, speckle, Gaussian, salt and pepper noises and made an observation regarding their characteristics and how they affect the image quality. After that, we made a detailed analysis on the existing ways to remove noise and more specifically, the ways to reduce ultrasonic image noise. After learning concepts of signals and systems and basics of filtering, we understood that low pass filtering such as Gaussian filtering desirably reduces noise in the image but consequently the image quality is slow reduced. Hence, we came up with a solution to use non-linear filtering techniques so that we can operate on the noisy parameters and the clarity parameters separately to get desirable results. After doing literature survey of over 10 technical papers in this domain and understanding multiple image processing techniques, we found that non-linear filtering using Bayes shrink and Visu Shrink reduced noise to a very good extent while keeping the quality of the image, satisfactory. As just visual comparison of the techniques couldn't be used to weigh the techniques, a standard unit of noise measurement called PSNR (Peak Signal to Noise Ratio) was used to compare the techniques. After surveying several technical papers and comparing with obtained results, we found that our method using Bayes shrink and Vizu Shrink had the best PSNR and produced quality images which could be used to doctors to diagnose the scanned images properly.

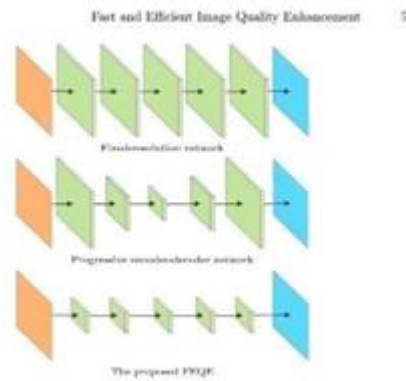
Bayes Shrink

Bayes shrink is an adaptive data driven threshold for image denoising using wavelet soft thresholding. It is implemented by assuming the Gaussian distribution for all the wavelet coefficients in every detail sub-band later we try to find the threshold which could minimize the Bayesian risk. As just visual comparison of the techniques couldn't be used to weigh the techniques, a standard unit of noise measurement called Peak Signal to Noise Ratio was used to compare the techniques. After surveying several technical papers and comparing with obtained results, we found that our method using Bayes shrink and Visu Shrink had the best PSNR and produced quality images which could be used to doctors to diagnose the scanned images properly.



FEQE

Google's vast data base and cloud supercomputing for our deep learning application. FEQE stands for Fast and Efficient Quality Enhancement, it is a program that uses a special sampling process called We are using a deep learning platform called TensorFlow, a Google APN, that allows us to use desubpixeling that ensures maximized quality of Image and also ease of processing. The down sampling is done in a way as to reduce the burden of processing but use multi-level sampling so that quality does not reduce. This removes the burden of the irreversible loss of information that happens during regular down sampling. Results in visually pleasing images in which medical diagnosis can be done easily and accurately. Also, since the number of channels used in the convolutional layers and very less, FEQE can be potentially very deep. This is so because FEQE is designed to produce the highest possible image quality under a certain memory and computational constraint. Hence, fast and efficient. Ex-perimental results thus shown prove that the proposed FEQE achieves significant improvements in both accuracy and run time compared to the other existing state-of-the-art methods.



IV. EXPERIMENTS AND RESULTS

Before arriving at the proposed solution, extensive research had been made regarding the current state-of-the-art methods to reduce speckle noise. Starting from Gaussian filtering to smoothen out the image to deep learning, such as FEQE. method, we have made deep observations, compared results and finalized on the proposed method. The PSNR along with the diagnosable of the image was improved considerably in the proposed method. The bottom up approach for this proposed solution started with the use of SRAD filter. Ultimate goal is to effectively remove noise while preserving the edges. Due to constructive and destructive interference from returning wave. SRAD works better than conventional filters. SRAD is basically like increasing de-haze and decreasing clarity from images. Linear filter are filters that process all the image parameters in the same way. Ex. Gaussian filter. The problem with this method is that even though the noise is reduced, the image gets blurred too and the edges don't retain the required sharpness. So, in this method, a dynamic filter that operates differently on the required image parameters and the vestigial noise parameters are discussed. Some of the existing technical of dynamic filtering include nonlocal means, anisotropic filter and bilateral filtering. Also, since multiplicative noise is hard to remove a Log function is used to change the multiplicative noise into additive noise for ease of removal. After the noise processing, an anti log function is used to get back the denoise image. Gradient magnitude is the rate of change in the pixels and SRAD first uses gradient magnitude to distinguish the edges from the homogeneous region. The edge regions are passed through the All-pass filter and the homogeneous regions are passed through the Gaussian filter to remove noise. Finally, these methods are compared to our proposed method and it was found that the PSNR and the quality of the image was found to be the best.

V. CONCLUSION

The proposed system is based on image processing using machine learning to remove the noise which could be introduced due to human error, environment in which the servers have been installed from medical images. The objective is achieved using following modules.

- Introducing the various kinds of noise along with speckle noise to the sample medical MRI images.
- Speckle noise is reduced by using Bayes threshold, and we have also used visu shrink to demonstrate the other ways which could be used to reduce the speckle noise which had been introduced in the first step.
- Sharpening of the image is made using tensor flow
- The contrast is improved using fuzzy logic and finally all the three enhanced images are combined using image fusion in the transform domain.

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