International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at: http://euroasiapub.org
Vol. 6 Issue 9 September- 2016,
ISSN (o): 2249-3905 ISSN (P): 2349-6525 | Impact Factor: 6.573 | Thomson Reuters ID: L-5236-2015

PERFORMANCE ANALYSIS OF OPTIMIZATION AND DE NOISING TECHNIQUES FOR ULTRASOUND AND ITS APPLICATION

Srinivas Akula [1], Dr. Amit Jain [2]

Department of Electronics and Communication Engineering

[1,2]OPJS University, Churu, Rajasthan (India)

Abstract

This research employs observational method to identify the performance analysis of optimization and de noising techniques for ultrasound images using anisotropic diffusion filter. Imaging modalities are helpless to noise and in this way require denoising of the images for despeckled diagnosis. Ultrasound is an efficient and beneficial imaging methodology that aides in diagnosing muscle related disorders. For motivation behind eliminating speckle noise in ultrasound images, we have adopted the anisotropic diffuser filter technique to remove noise from the image. performance measurements acquired from image reproduction methods per carotid PC channel and three existing contrast staining reduction programs. In view of speckle noise, anisotropic diffusion speckle reduction exceeds the expectations more traditional filters remove speckle and the anisotropic diffusion method usually in terms of mean protection, reducing difference and edge position.

.

1. OVERVIEW

Noise is probably the most annoying problem in the field of image processing. In medical images or ultrasound imaging, noise from cracks is more difficult. Eliminating that noise is an important pre-processing task. To obtain better performances, this paper presents anisotropic diffusion techniques optimized for ultrasound images. It is a new method to eliminate image noise without blurring the boundaries between the different regions. This method is based on the diffusion of diffusion in the direction of the gradient. To quantify the performance, we calculate the relationship between the mean gray level, the signal to noise ratio, the peak to peak noise ratio, the mean square error, the image fidelity and the structural content. This method provides a better result than the existing Perona-Malik anisotropic diffusion method.

A large number of spatial domain techniques are available in literature for speckle noise reduction in US images. Lee [1] and Frost [2] filters preserve the image edges while denoising by choosing different masks in homogeneous and non-homogeneous regions. Kuan filter [3] is similar to Lee filter but was presented with different diffusion equations. Although above mentioned filters have good denoising capabilities, performance of these filters is limited to size and shape of the used mask. For preserving edges while denoising, an isotropic dif-fusion technique was first proposed by Perona and Malik, referred to as Perona Malik Anisotropic Diffusion filter (PMAD) [4]. However this method works well with multiplicative speckle noise, it delivers significantly good results for images with additive noise. Speckle Reducing Anisotropic Diffusion (SRAD) [5] is a diffusion based filter which uses Partial Differential Equation (PDE) and Minimum Mean Square Error (MMSE) related to Lee filter. In SRAD filter, edges are preserved by allowing diffusion in homogeneous areas while restricting it across edges. Oriented SRAD filter [6] uses the local directional variance of the image gray levels for improving the performance of SRAD filter. Although diffusion filters are good in preserving edges while denoising, they employ iterative process for their operation and hence optimal number of iterations is required to preserve fine details present in the image. Non-Local Means (NLM) [7] filters are another class of important filters which perform denoising by weighted averaging of all the pixels in the noisy image. Coupé et al. [8] introduced a new NLM based filter in Bayesian framework for speckle reduction called Optimized Bayesian Nonlocal Mean filter (OBNLM). Some other popular spatial domain despeckling techniques are bilateral filtering [9] and detail preserving anisotropic diffusion (DPAD) filtering [10]. Over last few years, due to availability of high speed processors, hybrid techniques are gaining prominence. Although these techniques are not computationally efficient, they are becoming popular because of their ability to pro-vide better quality of denoised US images while pre-serving edges. A method based on the combination of SRAD and OBNLM filter is presented in [11].

2. CONCEPT OF NOISE AND DENOISING

An image can be characterized as a two-dimensional function, f (x, y), where x and y are the spatial directions (level) and the amplitude of any facilitate match (x, y) is known as the intensity or gray level of the image by then. Whenever x, y and the amplitude values of f are on the whole limited and discrete quantities, at that point it is known as a digital image.

- **Digital images**

It is a technique for changing over the image into digital frame and playing out a progression of connected activities to get a superior image or to get important data. Therefore, the different tasks were performed once an image has been digitized. Once an image has been filtered, different tasks can be connected to enhance quality and dispense with blurring.

- **Denoising**

Image diminishment is a fundamental assignment in image handling, both as a part in different procedures and as a procedure in itself. There are a few methods to wipe out image noise. The primary properties of a decent image noise removal show are edge conservation and de-noising. The straight models have customarily been utilized, the uproarious image as information,

- **Noise**

Each image framework experiences a typical "noise" issue. Undesirable information that can reduce the differentiation that crumbles the shape or size of a protest in an image and the blurring of edges or the weakening of fine points of interest in the image can be called noise. Noise may happen because of the accompanying reasons:

1. Because of the structure of the framework
2. Because of the gadgets caught by the image
3. Because of lighting conditions
4. The system used to get the image

- **Types of Noise**

Impulsive noise: Impulsive noise is named an undesirable quick snap in the image. This kind of noise is caused by electromagnetic impedance or off base synchronization recording of digital images. This class of noise is known as salt and pepper noise.

Gaussian noise: it is a factual kind of noise. It depends on the likelihood thickness function and this likelihood thickness function is constantly equivalent to the ordinary appropriation.

- **Additive White Gaussian Noise**

Additive White Gaussian Noise (AWGN) is a model in view of data hypothesis to duplicate the impact of numerous procedures that happen in our condition. The attributes are as per the following:

1. "Additive" to the data framework is added to any noise that might be characteristic.
2. "White" in light of the fact that the power is uniform over the entire recurrence band for any data framework. The white shading demonstrates uniform discharges in the obvious range for all frequencies.
3. "Gaussian" communicates a mean estimation of zero inside the time space in the typical dispersion.

Shot Noise: a standout amongst the most essential kinds of electronic noise is the trigger noise that begins in the electrical load. This sort of noise is included amid the securing time of an image..

$$S = v_{qn}\, sqrt(12)$$

In this equation, S is the trigger noise, it is the square root of the capture image. **Quantization Noise (Q):** the difference between input and output is called quantization error. Therefore, the quantization error can be between -1 / 2Q and + 1 / 2Q. This error can be considered as a quantization noise with RMS: it can be calculated by dividing the ADC interval by the number of steps in the staircase.

$$Q = \frac{V_{ref}}{2^N}$$

In this equation, where N is the quantity of bits in the ADC and the info range can be in the vicinity of 0 and the digital-simple converter. where is ADC

Anisotropic Noise: this kind of noise happens when the image is caught with edges of slanted review with the anticipated camera. For the end of anisotropic noise, the filter utilized is an anisotropic filter that reduces and preserves points of interest at extraordinary survey edges.

- **Speckle Noise**

Speckle is a "disorder" that reduces the nature of ultrasound images and engineered gap radar (SAR) images. Because of the challenges in deciphering images, splitting noise is a more major issue in SAR images.

3. IMAGE QUALITY EVALUATION METRICS

The nature of a despeckled image is analyzed by the accompanying standard image quality assessment measurements. The original image is spoken to by x (I, j) and the despeckled image is spoken to by x (I, j).

Peak Signal to Noise Ratio

Peak Signal to Noise Ratio (PSNR) (Sakrison 1997) is utilized to quantify the contrast between the original and segregated images of size M x N, and is evaluated utilizing the equation. It is expressed in decibels (dB).

$$PSNR = 10log_{10}\left(\frac{255^2}{MSE}\right)$$

where 255 is the maximum intensity in the grayscale image and MSE is the mean square error and is indicated in the equation:

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - \hat{x}(i,j))^2$$

Root Mean Square Error

Root Mean Square Error (RMSE) (González and Woods 2008) is the square root of the square error meanted on the M x N window and is calculated from the equation:

$$RMSE = \sqrt{\frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}(x(i,j) - \hat{x}(i,j))^2}$$

Edge Preservation Index

The edges of the filter storage capacity is evaluated using Edge Preservation Index (EPI) (Sattar et al 1997) and calculated as in the equation:

$$EPI = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N}(\Delta x(i,j)-\overline{\Delta x})(\Delta\hat{x}(i,j)-\overline{\Delta\hat{x}})}{\sum_{i=1}^{M}\sum_{j=1}^{N}(\Delta x(i,j)-\overline{\Delta x})^2(\Delta\hat{x}(i,j)-\overline{\Delta\hat{x}})^2}$$

Where $\Delta x(i,j)$ and $\Delta\hat{x}(i,j)$ represents the edge images of the original image $x(i\ j)$ and the despeckled image $\Delta\hat{x}(i,j)$ respectively. The edge images are the high-pass filtered versions of the x, y images, obtained with a standard 3x3 pixel approximation of the Laplacian operator. They $\overline{\Delta x}$ and $\overline{\Delta\hat{x}}$ are the mean intensities of Δx and $\Delta\hat{x}$ respectively. If the edge is well preserved during the removal process, the edge preservation index will be close to the unit.

Correlation Coefficient

Correlation Coefficient (CoC) (Sattar et al 1997) is used to measure the similarity between the original image and despeckled image, which is given in Equation:

$$CoC = \frac{\sum(x-\bar{x})(\hat{x}-\bar{\hat{x}})}{\sum(x-\bar{x})^2(\hat{x}-\bar{\hat{x}})^2}$$

where $\bar{x}$ and $\hat{x}$ are the mean of the original and despeckled image respectively.

Mathematical Framework of Anisotropic Diffusion Filter

Speckle noise adverse affects ultrasound imaging, and a basic drop in contrast resolution conceivably will be accountable for the second rate nature of the ultrasound with respect to MRI. By and large, speckle noise is too called as texture. Rearranged portrayal of the speckle [2] is delineated as,

$$g(n,m) = f(n,m) * u(n,m) + \xi(n,m) \qquad (1)$$

Where n and m are the axial and lateral indices of the ultrasound image, g (n, m) is the experiential image, u (n, m) is the multiplicative component and ξ (n, m) is the additive component of the noise in speckles. In general, for an ultrasound, the additive component is not considered, so the equation can be rewritten as,

$$g(n,m) = f(n,m) * u(n,m) \qquad (2)$$

Or $\qquad f(x, y) = g(x, y)n(x, y),$

$$\begin{cases} \frac{\partial I}{\partial t} = div[c(|\nabla I|).\nabla I] \\ I(t = 0) = I_0 \end{cases} \qquad (3)$$

Where ∇ is the gradient operator that is used to identify the edge of the image as a step intensity discontinuity; div is the divergence operator, | | represents the magnitude, c (x) is the diffusion coefficient and I_0 is the initial image. Furthermore, the authors recommended the application of 2 coefficients:

$$c(x) = \frac{1}{1+\left(\frac{x}{k}\right)^2} \qquad (4)$$

$$c(x) = \exp\left[-\left(\frac{x}{k}\right)^2\right] \qquad (5)$$

Where k is a parameter for edge magnitude.

If $|\nabla I| \gg k, then\ c(|\nabla I|) \to 0,$

resulting in an all-pass filter. And,

if $|\nabla I| \ll k, then\ c(|\nabla I|) \to 1,$

resulting in an isotropic filtering i.e. Gaussian filtering. Eq. (1) is denoted as:

$$I_s^{t+\Delta t} = I_s^t + \frac{\Delta t}{|\bar{\eta}_s|} \sum_{p \in \bar{\eta}_s} c\left(\nabla I_{s,p}^t\right) \nabla I_{s,p}^t \qquad (6)$$

where

$$I_s^t$$

discrete image, s is the pixel position in a discrete 2D grid, *t* is the time step size,

$$\bar{\eta}_s$$

spatial neighborhood of *s* is,

$$|\bar{\eta}_s|$$

In the window the number of pixels is.

$$\nabla I_{s,p}^t = I_p^t - I_s^t, \forall\, p \in \bar{\eta}_s \qquad (7)$$

The primary benefits of AD are intra-region smoothing and edge support. Advertisement accomplishes the outcomes greatly useful for images that are polluted by added substance noise. Additionally, this method is favored in light of its low computational complexity. A few advancements for despeckling have been clarified in the writing for ultrasound images. Similarly as noise expulsion, anisotropic diffusion can be utilized as a part of edge location algorithms. When spreading with an edge looking for the diffusion coefficient for a specific number of cycles, the image can develop into a stable image in pieces with the boundaries between the coherent components recognized as edges.

4. APPLICATION OF ANISOTROPIC DIFFUSION TECHNIQUE

Anisotropic diffusion used to expel the noise of advanced images without blurring the edges. With a constant diffusion coefficient, the anisotropic diffusion conditions decrease to the heat condition which is proportional to the Gaussian defocus. This is perfect for ejecting noise and also darkening the edges unpredictably. At the moment when the diffusion coefficient is selected as an edge in search of work, for example, in Perona and Malik, the subsequent conditions excite the diffusion (therefore, soften) within the regions and restrict it transversely with respect to the full edges. . From now on, edges can be saved by expelling the noise from the image.

5. CONCLUSION

The consequences of the investigation on anisotropic diffusion and NLM methods, we can presume that the NLM method is prevalent and creates better outcomes for the removal of both qualitatively and quantitatively ultrasound images. Additionally work will be performed in which the radiologist and the doctors will partake to approve the qualitative outcomes and focus on enhancing the NLM algorithm with various varieties keeping in mind the end goal to give more exact outcomes to better finding and understanding.

In this paper new methodologies are displayed to filter the multiplicative noise of medical ultrasound images. A correlation of the performance between the transient transformation Fourier Transform (STFT) and the Wigner-Ville Transform (WVT) is performed. In the wake of sectioning the image into portions of little and covering dyadic lengths, STFT or WVT is connected to each fragment separately. A base number of coefficients is utilized for the STFT or WVT time frequency design, which was discovered adequate to speak to the whole time frequency design. At the point when connected to mimicked and genuine ultrasound images, these methodologies defeated the most widely recognized nonlinear de-noising techniques, for example, Wavelets, Total Variation Filtering and Anisotropic Diffusion Filtration. STFT has given maximum cleanliness of the noise of the spots, while WVT has kept up the edges of the image and gave the most elevated resolution.

REFERENCES

[1]. Lee, J. S. Digital image enhancement and noise filtering by use of local statistics. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1980, vol. PAMI-2, iss.2 pp. 165-168.

[2]. Frost, V. S., J. A. Stiles, K. S. Shanmugan And J. Holtzman. A model for radar im-ages and its application to adaptive digital filter-ing of multiplicative noise. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1982, vol. PAMI-4, iss. 2, pp. 157–166.

[3]. Kuan, D. T., A. A. Sawchuk, T. C. Strand And P. Chavel. Adaptive noise smoothing filter for images with signal-dependent noise. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1985, vol. PAMI-7, iss. 2, pp. 165–177.

[4]. Perona P. And J. Malik. Scale-space and edge detection using anisotropic diffusion. IEEE Transactions on Pattern Analysis and Machine Intelligence. 1990, vol. 12, iss. 7, pp. 629–639.

[5]. Yu, Y. And S. Acton. Speckle reducing anisotropic diffusion IEEE Transactions on image Processing, 2002. Vol. 11, iss 11, pp 1260-1270.

[6]. Krissan, K, C.F. Wetin, R. Kikinis and K.G. Vosburgh, Oriented Speckle reducing anisotropic diffusion IEEE Transactions on image Processing 2007, vol. 16, iss 5, pp 1412-1424.

[7]. Buades, A, B. Coll and J.M. Morel, A review of image denoising algorithms a new one Multiscale Modelong and Simulation 2005, vol. 4, iss 2, pp 490-530.

[8]. Coupe, P., P. Hellier, C. Kervrann and C. Barillot, Nonlocal means-based speckle filtering for ultrasound images, IEEE Transactions on image Processing, 2009, vol. 18, iss 10, pp. 2221-2229.

[9]. Tomasi, C. And R. Manduchi. Bilateral fil- tering for gray and color images. In: International Conference on Computer Vision. Bombay: IEEE, 1998, pp. 839–846.

[10]. Fernandez, S. A. And C. A. Lopez. On the estimation of the coefficient of variation for anisotropic diffusion speckle filtering. IEEE Transactions on Image Processing. 2006, vol. 15, iss. 9, pp. 2694–2701.

[11]. Gungor, M. A. And I. Karagoz. The homogeneity map method for speckle reduction in diagnostic ultrasound images. Measurement. 2015, vol. 68, iss. 5, pp. 100–110.