EFFECT OF DESEPCEKLING OF ULTRASOUND IMAGES USING ANISTROPIC DIFFUSION METHOD

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Abstract:

The ultrasound imaging methodology is the efficient and cost effective way of identifying disease. The organs may contain abnormalities like swelling, lesion, change in appearance and position, or may not. The ultrasound images suffer from speckle noise arising due to image sensor. The noise will reduce the contrast and resolution of image. To handle with noise in breast ultrasound images anisotropic diffusion method (ADM) guided by Gabor filter is preferred. To validate the good sonographic images the indices to be considered are the Pratt's figure of merit and the mean radial distance (in pixels).The value of Figure of merit and mean radial distance indices should be equal to 1 and 0 to show needed edge preservation. The value of figure of merit and mean radial distances of ADM is 0.83 and 4.19. The works involves the implementation of ADM without Gabor filter for ultrasound images for various organs and see how it works for different organs as it is originally designed for breast ultrasound.

Keywords: Ultrasound Imaging, speckle noise, anisotropic diffusion method.

I INTRODCUTION

Quality of ultrasound image is affected mainly an inherent imaging artefact like speckle. Speckle arises from interference effects between returning echoes produced by discontinuities of tissue below ultrasonic beam resolution. Speckles degrade the US image by masking fine structures and also the signal-to noise ratio (SNR). The kind of granular pattern Speckle noise have granular pattern. Any Computer aided design mines the shape or contour features from segmented area of image to serve that purpose image ROI should be completely noise free. In order to reduce the speckle noise a method called anisotropic diffusion method is preferred and it is usually implemented for breast images. Usually the method is guided by Gabor filtering method hence also called as anisotropic diffusion guided by Gabor filter (ADLG).The advantage of anti-diffusion filtering is the calculation of gradient-based conduction coefficient to preserve the edges. The goal of the work is to work out this type of filtering without Gabor filter for organs like liver, kidney, uterus, and breast and see the result.

Figure 1: An ultrasound image contaminated with speckle noise

II METHOD

Anisotropic diffusion filtering:

The nearest neighbour calculation for discretization of the non-linear partial differential equation of ADF approach is given as per literatures as,

$$I_{i,j}^{t+1} = I_{i,j}^{t} + \tau \sum_{d \in \mathcal{N}_d} [g(|\nabla_d I|)\nabla_d I]_{i,j}^{t}$$

where t is the iteration step. $I^t i;j$ is the noisy pixel at iteration t; the pair i, j is the pixel location; 0 < t < ¼ for the numerical approximation to be stable .|x| denotes the magnitude; N_d indicates the set of d-directions for the nearest-neighbor difference, N_4 = {N, S, W, E} or N_8 ={N 4, NW,SW, NE, SE}.
The function g(x) in equation of ADF is the conduction coefficient updated at every iteration is given as,

$$g(\nabla I) = \frac{1}{1 + (|\nabla I|/\kappa)^2}$$

The selection of a k value depends strongly on the noise power and regional contrast, and it should be adapted for each pixel in the image instead of using a global k parameter.

III IMAGE DATA SETS

The despeckling method is implemented for synthetic liver, breast, uterus, kidney images. The image data set is taken from online medical images and ultrasound images website. Nearly 100 images are taken of different organs mentioned are taken for ADM evaluation. Images may be normal, having lesions, tumour benign or malignant with round, oval or irregular shape. The image dataset acquired may or may not contain speckle, in order to test the purpose speckle noise is manually added in some cases.

IV IMPLEMENTATION AND RESULTS

The algorithm is implemented in Matlab software. The speckle noise is added and filtering is done. A GUI window is being created to test the process.

The noise command given is; `imnoise(b,'speckle',0.04)`

The MatLab Code to find divergence is given by,

```
I_W_N(:,:,1) = IN1.W_N.D1; I_W_N(:,:,2) = IN1.W_N.D2;
I_N_E(:,:,1) = IN1.N_E.D1; I_N_E(:,:,2) = IN1.N_E.D2;
I_E_S(:,:,1) = IN1.E_S.D1; I_E_S(:,:,2) = IN1.E_S.D2;
I_S_W(:,:,1) = IN1.S_W.D1; I_S_W(:,:,2) = IN1.S_W.D2;
I_NW_NE(:,:,1) = IN1.NW_NE.D1; I_NW_NE(:,:,2) = IN1.NW_NE.D2;
```

```
I_NE_SE(:,:,1) = IN1.NE_SE.D1; I_NE_SE(:,:,2) = IN1.NE_SE.D2;
I_SE_SW(:,:,1) = IN1.SE_SW.D1; I_SE_SW(:,:,2) = IN1.SE_SW.D2;
I_SW_NW(:,:,1) = IN1.SW_NW.D1; I_SW_NW(:,:,2) = IN1.SW_NW.D2;
```

Conduction Coefficent is computed as ,

```
C_W_N = IN2.C_W_N;
C_N_E = IN2.C_N_E;
C_E_S = IN2.C_E_S;
C_S_W = IN2.C_S_W;
C_NW_NE = IN2.C_NW_NE;
C_NE_SE = IN2.C_NE_SE;
C_SE_SW = IN2.C_SE_SW;
C_SW_NW = IN2.C_SW_NW;
```

Intensity-gradient responses in N8

```
I_W_N(:,:,1) = abs(IN1.W_N.D1).^2; I_W_N(:,:,2) = abs(IN1.W_N.D2).^2;
I_N_E(:,:,1) = abs(IN1.N_E.D1).^2; I_N_E(:,:,2) = abs(IN1.N_E.D2).^2;
I_E_S(:,:,1) = abs(IN1.E_S.D1).^2; I_E_S(:,:,2) = abs(IN1.E_S.D2).^2;
I_S_W(:,:,1) = abs(IN1.S_W.D1).^2; I_S_W(:,:,2) = abs(IN1.S_W.D2).^2;
I_NW_NE(:,:,1) = abs(IN1.NW_NE.D1).^2; I_NW_NE(:,:,2) =
abs(IN1.NW_NE.D2).^2;
I_NE_SE(:,:,1) = abs(IN1.NE_SE.D1).^2; I_NE_SE(:,:,2) =
abs(IN1.NE_SE.D2).^2;
I_SE_SW(:,:,1) = abs(IN1.SE_SW.D1).^2; I_SE_SW(:,:,2) =
abs(IN1.SE_SW.D2).^2;
I_SW_NW(:,:,1) = abs(IN1.SW_NW.D1).^2; I_SW_NW(:,:,2) =
abs(IN1.SW_NW.D2).^2;
```

Adaptive kappa in N8

```
R_W_N = IN2.R_W_N;
R_N_E = IN2.R_N_E;
R_E_S = IN2.R_E_S;
R_S_W = IN2.R_S_W;
R_NW_NE = IN2.R_NW_NE;
R_NE_SE = IN2.R_NE_SE;
R_SE_SW = IN2.R_SE_SW;
R_SW_NW = IN2.R_SW_NW;
```

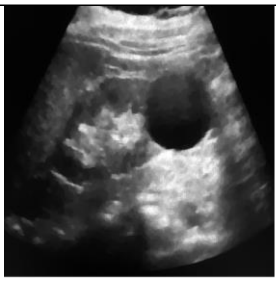
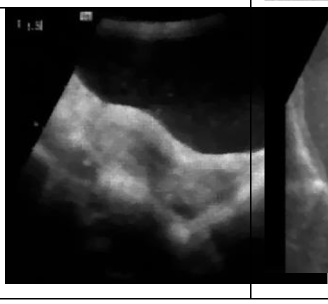
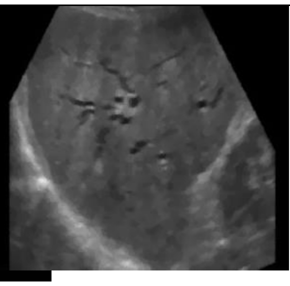
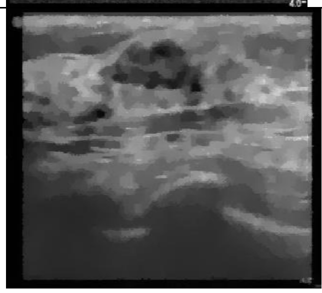
Organ Name	Kidney	Uterus	Liver	Breast
a				
b				

Figure 2 a: Noisy Image b: Output of Conventional ADM without Gabor filter

V CONCLUSION

Speckle reduces image quality by reducing the resolution; this in turn reduces the ability to differentiate between two neighbouring tissues. On trying to eradicate with ADM it is blurring small discontinuities and making sharp edges .So to avoid this various ADM methods can be used like log- gabor ADM,texture oriented ADM,speckle reducing ADM.

VI REFERENCES

[1] Alvarenga AV, Infantosi AFC, Pereira WCA, Azevedo CM. Assessingthe performance of morphological parameters in distinguishingbreast tumors on ultrasound images. Med Eng Phys 2009;32:49–56.

[2] Anderson ME, Trahey GE. A seminar on k-space applied to medical ultrasound.Department of Biomedical Engineering, Duke University; 2006.

[3] Cardoso FM, Matsumoto MMS, Furuie SS. Edge-preserving speckletexture removal by interference-based speckle filtering followedby anisotropic diffusion. Ultrasound Medicine in Biology 2012;38:1414–1428.

[4] Cheng HD, Shan J, Ju W, Guo Y, Zhang L. Automated breast cancer detection and classification using ultrasound images: A survey.Pattern Recogn 2010;43:299–317.

[5] Eur J Cancer 2011;47:1021–1026.Czerwinski RN, Jones DL, O'Brien WD. Detection of lines and boundaries in speckle images—Application to medical ultrasound. IEEE Trans Med Imaging 1999;18:126–136.

[6] Dantas RG, Costa ET. Ultrasound speckle reduction using modified Gaborfilters. IEEE Trans Ultrason Ferroelectr Freq Control 2007;54: 530–538.

[7] Perona P, Malik J. Scale-space and edge detection using anisotropic diffusion. IEEE Trans Pattern Anal Mach Intell 1990;35:629–639. Petrou M, Garcıa-Sevilla P. Image processing. Chichester: Wiley; 2006.

[8] Yang Z, Fox MD. Speckle reduction and structure enhancement by multichannel median boosted anisotropic diffusion. EURASIP J Adv Signal Process 2004;2004:2492–2502.

[9]Allwyn ganadass A,Sathish Babu.S,P.ArunKumar "Localization of Seizures in Epilepsy using Low Frequency Fluctuations from Rs-fMRI"International Journal of Recent Technology and Engineering 8 (4), 10576-10579, Volume-8 Issue-4, November 2019.