Survey Paper on Filtering Technique in Ultrasound For Kidney, Liver and Pancreas Image Using Matlab

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Abstract

Ultrasound is a well-known medical imaging modality on its ability to visualize kidney, liver and pancreas accurately. However, speckle noise caused by constructive and destructive interferences of the wavelets will disturb the image of the organs. The main goal of this research is to identify the most suitable and reasonable filtering techniques.

Keywords: *filter, ultrasound, kidney, pancreas, liver*

Introduction:

Speckle noise, also known as granular noise often exists in ultrasound images results in increasing of mean gray level of a local area.[1] Consequently, the image is difficult to interpret and analysed. It is impossible to get rid of noise in electrical system but we can reduce the effect of noise.

Past research has proposed several methods to remove speckle noise. Prema et. Al. [2] states that Gaussian Low Pass Filter is the most optimal filter in differentiate cystic and normal kidney images while [3] choosing Gaussian Low Pass Filter at threshold value 0.7 to generate true kidney ROI. In [4] stated that median filter is the best non-linear filtering while Lee filter works the best for linear filtering. Sunganya et. Al. [5] discovers that morphological filter is most effective filter compare with Wiener Filter and Bayes Wavelet Filter. P. S. Hiremath et. al.[6] proposed new linear regression model for Gaussian representation. The findings state in terms of PSNR and computational time required for denoising, the proposed method is better than the contourlet transform method.

Mariam et. Al. [7] and Wan Mahani et. Al. [8] agrees that Median filter gives the best performance especially on detecting the edges of the image.

Digital image processing has a broad spectrum of applications such as remote sensing, medical processing, radar, image transmission and storage. In medical applications, the images are mostly used for patient screening and monitoring or for detection of tumors and various other diseases using different imaging modalities like X ray, CT scan, MRI images and ultrasound (US) images. Many artefacts or inherent imperfections are also present in the images which may be any type of noise etc. Therefore, many image processing techniques are used for noise removal and image enhancement

Literature survey:

In this study, five filtering technique were applied to images of kidney, liver and pancreas.

50 ultrasound images for each organ (kidney, liver and pancreas) were taken from volunteers

of University Tun Hussein Onn Malaysia (UTHM) in Medical Imaging Laboratory using Toshiba Nemio 10 ultrasound machine with 3.75 MHz PVM-375AT transducer. Volunteers are ensured to drink water 30 minutes before the experiment to produce clear images. The images taken started with kidney, followed by liver and pancreas. The images then saved in ultrasound machine and extracted to Matlab for analysis. All the images experienced different filtering technique discussed in next subsection. Performance of each filtering technique for each images are tested using MSE and PSNR technique. Figure 1 shows the flowchart of the proposed method.

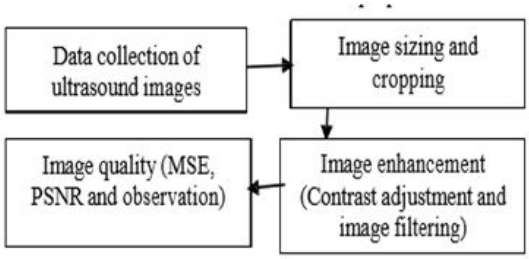

Fig. 1: Flowchart of the proposed method

Methodology:

A. Image Acquisition

Ultrasound machine is set into default setting where the gain is 86 while depth of scanning is 10 cm, 12 cm, and 7 cm for kidney, liver and pancreas, respectively. Kidney is scanned in longitudinal position while liver and pancreas are scanned in transverse position. The conditions are standardized to ensure the quality of each image. 50 images are taken for each organ. The images then cropped into specific sizes which is [280 150 400 400] before converted to grayscale. In our research, grayscale image identified by function 'gray' in Matlab coding. The cropped and converted images of kidney, liver and pancreas are shown in Fig. 2 (a) – (c) respectively.

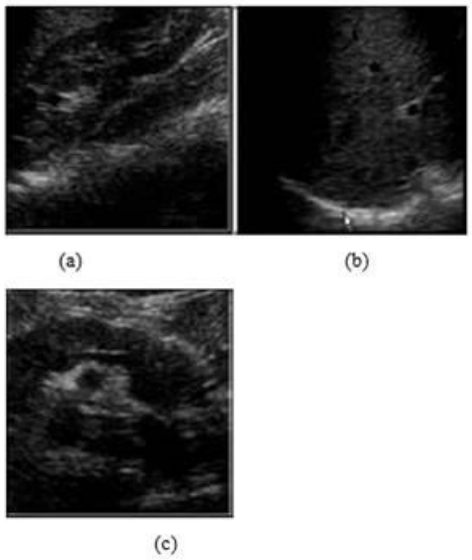

Fig. 2: Cropped and converted image in grayscale of each organ where (a) kidney (b) liver (c) pancreas

B. Image Filtering

1. Median Filter

Median filter is a non-linear filter which is known as rank filtering [9]. It is the best filtering technique in reducing salt and pepper noise while maintaining the sharp edges in an image [10]. However, the main weakness of this filter is it cannot differentiate between noisy and non-noisy details. Median filter works when the values of a pixel in column by column neighbourhood window are ranked according to intensity. In this paper, 3 by 3 neighborhood value is used as default value which makes the fifth value from ninth pixel becomes the output value for the pixel under evaluation. Coding below used in Matlab to determine median filter. d = medfilt2(gray,[3 3]); %gray: input image in gray scale %d: output image after median filtering

2.Wiener Filter

Wiener filter is a linear filter where it removes additive noise and minimizes the overall mean square error in the process of inverse filtering and noise smoothing It executes the deconvolution by high pass filter and removes the noise with a compression operation. In Matlab, wiener2 function with low pass-filtering grayscale image which had been degraded by constant power of additional noise. wiener2 used smart pixel adaptive Wiener method based on statistics estimated from a local neighbourhood of each pixel. In this case, 3x3 neighbourhood is choose as a default value. Below show the complete coding in Matlab for Wiener filter. e = wiener2(gray,[3 3]); %e: output image after Wiener filter %gray: input image

3. N-D Filter

The imfilter function used to perform filtering of multidimensional images. It computed each elements of the output using double-precision floating point. It shortened the output element that exceeds the range of certain type and rounding the fractional value if the original image was an integer or logical array. Our research used constant h in Matlab coding as the output of approximate linear camera motion which results on array of same data type as input image array. Below is the coding for N-D filtering in Matlab. h = fspecial('motion', 50, 45); i = imfilter(gray, h); %h: output of approximate linear camera motion %i: output image after N-D filter

4. Entropy Filter

The entropy is null for a flat image and increases when the data contains some information [11]. Local entropy of grayscale image returned the array. A value of 9-by-9 neighbourhood surrounds are correspond pixel in input image. The output image size is same as the input image size. In Matlab, entropyfilt is the function used in creating texture image. Full coding below use by the author to perform entropy filter. j = entropyfilt(gray); %j: output image after experienced entropy filter

5. 2-D Order Statistic Filter

Function of 2-D order-statistic filter in Matlab is ordfilt2. The filter sorted pixel values over a neighborhood, select and replaced each element in original image by kth largest value element. The value specified by non–zero element in domain. The source code for ordfilt2 is shown below. A real scalar of integer of class degree given is specified to replace the target pixel. g = ordfilt2(gray,25,true(5)); %g: output image after filtered with 2-D Order Statistic filter

C. Performance Analysis

1. Mean Square Error

Generally, mean-squared error (MSE) used to evaluate the performance of a predictor which related with the concepts of bias, precision and accuracy in statistical estimation. Calculation of MSE between the input array and output array in the same size and class can be array of any other dimension. The lower value of MSE, the output image quality is better. In general, Matlab source codes used to calculate MSE are as follow. X= (double(reference image) - double(filtered image)) ^2; MSE = sum(X (:))/(rows*columns) ; %X: difference value between reference image and filtered image %MSE: Value of MSE in image

2. Peak Signal to Noise Ratio (PSNR)

Peak signal-to-noise ratio (PSNR) measures the quality of lossy and lossless compression after a reconstruction. It often used to measure the quality between original and compressed image. Highest PSNR value gives the best image quality. The calculation of PSNR in MATLAB coding is stated below. PSNR = 10*log10(255^2/MSE) ;% calculation

3. Visual Inspection

Visual inspection of images is commonly measured by experts [12]. The main weakness of this method is it is subjective analysis according to the eye of the experts. For this purpose, the observers are given enhanced image randomly and choose the best images without taking any into consideration aspect of other part being enhanced, smooth, blurred or removed away .

Results and Discussion

The result of filtering image for kidney, liver and pancreas are shown in Fig. 3, Fig. 4 and Fig. 5, respectively.

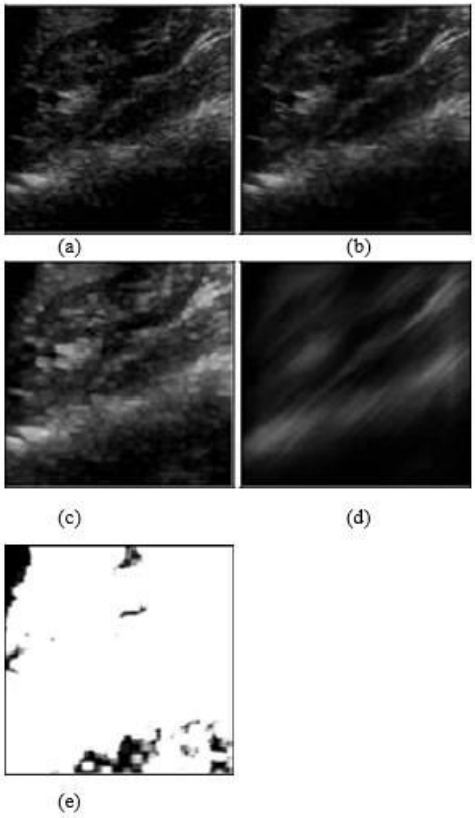

Fig. 3: Result of kidney image filtering; (a) median filter (b) Wiener filter (c) 2-D order-statistic filter (d) N-D filter (e) entropy filter

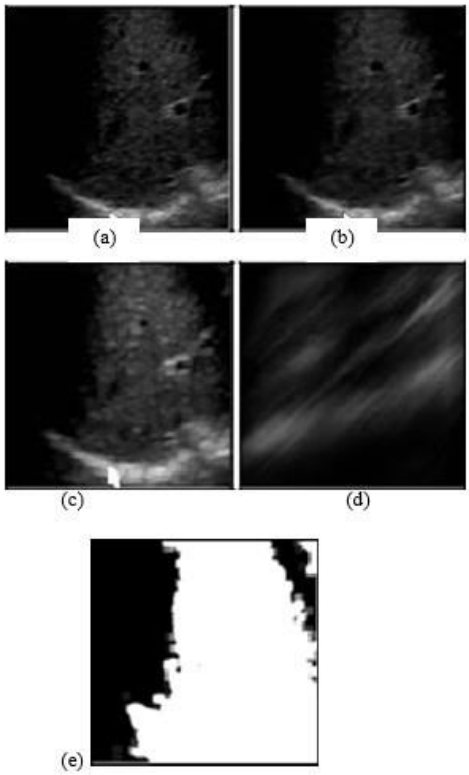

Fig. 4: Result of image enhancement of original liver image using image filtering; (a) median filter (b) Wiener filter (c) 2-D order-statistic filter (d) N- D filter (e) entropy filter

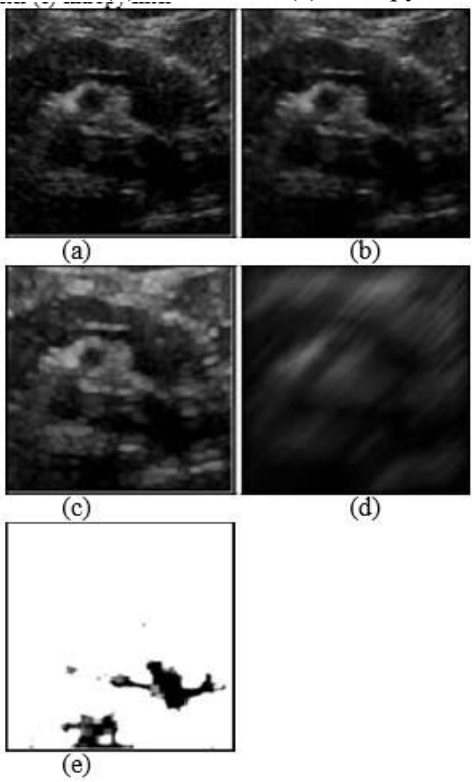

Fig. 5: Result of image enhancement of original pancreas image using image filtering; (a) median filter (b) Wiener filter (c) 2-D order-statistic filter (d) N-D filter (e) entropy filter

Based on the observation of images after filter, we can see that 2-D order-statistic filter result in blurring image while N- D filter and entropy filter demolish the image. Hence, median filter and Wiener filter are two filters considerate suitable with the images.

In general, the lowest mean-squared error (MSE) means the performance of an image is the best which means high quality of image. Fig. 7 illustrates the mean values of MSE for all organs with different types of filter. Based on the graph in Fig. 7, the value of median filter is the lowest in kidney and pancreas images, which is 14.44 and 11.3 respectively. Meanwhile, the value of MSE in Wiener filter is the lowest in liver images (23.42). Entropy filter is obviously not suitable to

Graph of Peak Signal-to-Noise Ratio

40 35 30 25 20 15 10 5 0

be use in kidney, liver and pancreas images of this project because the filter produced high value of MSE that is 1476.48, 1351.38 and 1381.48 respectively.

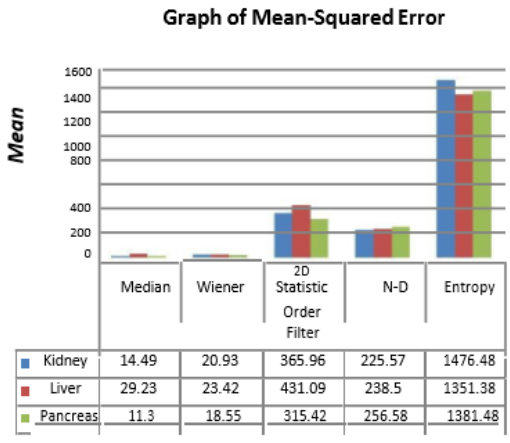

Fig. 6: Mean value of MSE for kidney, liver and pancreas

The highest peak signal-to-noise ratio (PSNR) gave the best performance of an image which leads to a high image quality. Fig. 8 shows the mean values of PSNR for all organs with different types of filter. Based on this graph, median filter gave the highest value in kidney and pancreas images (36.63 and 37.71) while Wiener filter is the highest in liver image (34.45). Entropy filter is not suitable in filtering organ images because the mean values of PSNR for all organs are lowest. Entropy filter is the not suitable to filter images as it produce the lowest value of PSNR followed by 2-D statistic order filter and N-D filter. Wiener and median filter are two filtering technique taken into consideration to filter kidney, liver and pancreas images.

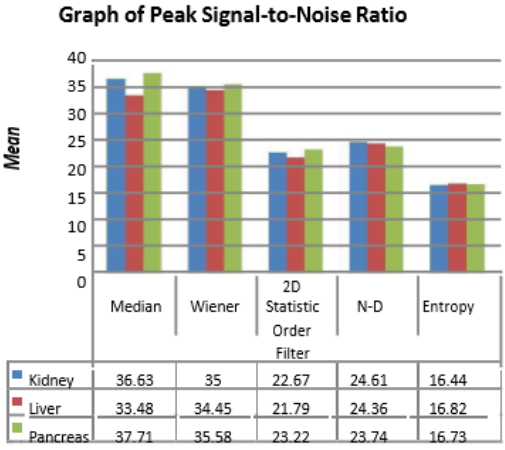

Fig. 7: Mean value of PSNR for kidney, liver and pancreas.

CONCLUSION

Based on the result of MSE and PSNR, the best filtering technique used for kidney and pancreas are median filter while the best filter for liver is Wiener filter. This synchronize with the result of observer in visual inspection. Median filter is the most suitable technique in enhancing the edges of the images while Wiener filter smooth the images.

REFERENCES

[1] P. Patidar, M. Gupta, S. Srivastava and A. K. Nagawat, “Image de- noising by various filters for different noise,” International Journal of Computer Applications, vol. 9, no. 4, pp. 45–50,

November 2010, Published By Foundation of Computer Science.

[2] P. T. Akkasaligar and S. Biradar, "Classification of medical ultrasound images of kidney," IJCA Proceedings on International Conference on Information and Communication Technologies (ICICT), vol. 3, pp. 24- 28, October 2014.

[3] W. M. Hafizah and E. Supriyanto, "Automatic generation of region of interest for kidney ultrasound images using texture analysis", International Journal of Biology and Biomedical Engineering, Issues 1, Vol. 6, pp. 26-34, 2012.

[4] K Mohan and I L. Aroquiaraj, "Comparative analysis of saptial filtering techniques in ultrasound images," International Journal of Computational Intelligence and Informatics, vol. 4, no. 3, pp. 207-213, December 2014.

[5] D. Suganya and S. Devi, "Effective noise reduction techniques for despeckling ultrasound medical images," Journal of Computer Applications, vol. 5, pp. 52-58, February 2012.

[6] P. S. Hiremath, P. T. Akkasaligar and S. Badiger, "Linear regression model for gaussian noise estimation and removal for medical ultrasound images," International Journal of Computer Applications, vol. 50, no. 3, pp. 11-15, July 2012.

[7] M. W. Attia, F. E. Z. Abou-Chadi, H. El-D. Moustafa and N. Mekky, "Classification of ultrasound kidney images using PCA and neural networks," International Journal of Advanced Computer Science and Applications, vol. 6, no. 4, pp. 52-57, 2015.

[8] W. M. Hafizah, and E. Supriyanto, "Comparative evaluation of 2015 IEEE Student Conference on Research and Development (SCOReD) 405
ultrasound kidney image enhancement techniques." International Journal of Computer Applications 21, no. 7, pp 15-19, 2011.

[9] K. Arulmozhi, S. A. Perumal, K. Kannan, and S. Bharathi, "Contrast improvement of radiographic images in spatial domain by edge preserving filters," IJCSNS International Journal of Computer Science and Network Security, vol. 10, no. 2, pp. 233-240, 2010.

[10] S. Ambardar and M. Singhal, "A review and Comparative Study of De-noising Filters in Ultrasound Imaging," International Journal of Emerging Technology and Advanced Engineering, vol. 4, no. 8, pp. 824- 831, 2014.

[11] J-L. Starck and F. Murtagh, "Multiscale entropy filtering," Signal Processing, vol. 76, no. 2, pp. 147-165, 1999.

[12] R. Rosa and F. C. Monteiro, "Performance analysis of speckle ultrasound image filtering", Computer Methods in Biomechanics and Biomedical Engineering: Imaging & Visualization, pp. 1-9, 2014.