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Filtering Technique in Ultrasound Images for Kidney, Liver and Pancreas for Disease Identification

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Abstract

In this paper, most accurate and reasonable filtering technique is identified for removing noise due to constructive and destructive interferences of the wavelets. this noise may lead to disturbance in the images of the organs which are obtained using Ultrasound a well-known medical imaging modality on its ability to visualize kidney, liver and pancreas accurately. The images are cropped into specific sizes before converting it into grayscale image. Each of the images is then filtered using median filter, Wiener filter, 2-D order-statistic filter, N-D filter, and Entropy filter. Performance of each filter are analysed with MSE and PSNR. The result of this paper will show which of the filters is best suited.

Keywords: *filter, ltrasound, kidney, pancreas, liver.*

Introduction:

Speckle noise also known as granular noise which are often found in ultrasound images. Which leads to difficulty in interpreting and analysing the images. It is impossible to get rid of noise in electrical system but we can reduce the effect of noise

In this paper, we are proposing different filtering techniques will be applied on the images of kidney, liver and pancreas which are obtained by ultrasound scanning and the best filtering technique will be identified.

The different kinds of filters are:

Median Filter

Wiener Filter

N-D Filter

Entropy Filter

2-D Order Statistic Filter

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, grayscale image identified by function ‘gray’ in Matlab coding. The cropped and converted images of kidney, liver and pancreas.

Thus the problem obtain is The ultrasonic imaging speckle noise makes it difficult to distinguish between normal tissue and

pathological tissue. Which may lead to wrong diagnosis of the patient. It is advisable to use the most suitable and accurate filter to remove this noise.

Use of these filtering technique can achive the following objectives :

- Data collection of ultrasound images.
- Image quality check (MSE, PSNR and observation).

Literature survey:

Past research has proposed several methods to remove speckle noise.

[1] P. T. Akkasaligar and S. Biradar: Medical images are normally affected by noise due to various sources of interferences and other phenomena that affect the process of measurement in an imaging and acquisition system.

[2] W. M. Hafizah and E. Supriyanto: proposed new linear regression model for Gaussian representation. States that Gaussian Low Pass Filter is the most optimal filter in differentiate cystic and normal kidney images while choosing Gaussian Low Pass Filter . proposed new linear regression model for Gaussian representation. The findings state in terms of PSNR and computational time required for diagnosing, the proposed method is better than the contour let transform method.

[3] K Mohan and I L. Aroquiaraj: Comparative analysis of saptial filtering techniques in ultrasound images. Thr various filter techniques applied in the speckle noise removal from ultrasound images. In many despeckling filters available in speckle reduction some are best suited in ultrasound speckle noise images. The despeckle image evaluation quality measurement RMSE and PSNR are compared to the ultrasound images in despeckling for the spatial domain filter.

[4] D. Suganya and S. Devi: Effective noise reduction techniques for despeckling ultrasound medical images. The speckle noise can occurred in during the processing of image acquisition or restoration. If speckle noise is occurred in medical images it might be less quality and effects the physicians interpretation.

[5] M. W. Attia, F. E. Z. Abou-Chadi, H. El-D. Moustafa and N. Mekky: The medical ultrasound is considered on affective easy and inespencive diagnostic tool for a variety of diseases compared to other modalities recently, its use as increased dramatically as a result of the development of new technologies that facilitates the production of high quality images in addition , this technologies made the ultrasound devices smaller and more offordable to the clinician.

Proposed Method:

System Architecture

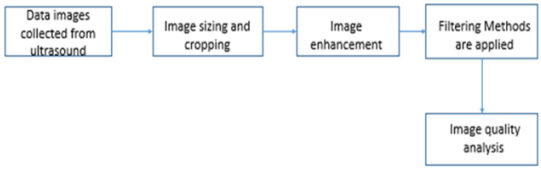

Fig.1: System Architecture

The speckle noise makes it difficult to distinguish between normal tissue and pathological tissue. Which may lead to wrong diagnosis of the patient. It is advisable to use the most suitable and accurate filter to remove this noise.so few different filtering techniques need to be applied in order to find the best and the most accurate filter. The quality of the resulting image is based on mean square error and PSNR.

System Design

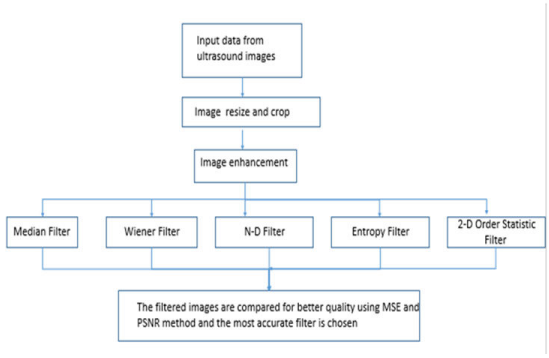

Fig. 2: System Design

Median Filter: Median filter is a non-linear filter which is known as rank filtering . It is the best filtering technique in reducing salt and pepper noise while maintaining the sharp edges in an image . 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 project, 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

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.

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.

Entropy Filter: The entropy is null for a flat image and increases when the data contains some information . 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.

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.

Methodology:

Methodology Diagram

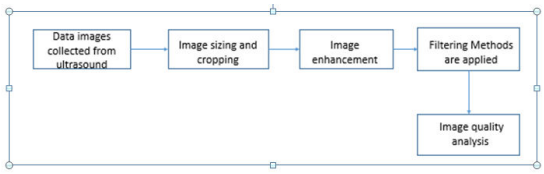

Fig.3: Methodology diagram

A few number of ultrasound images of kidney, liver and pancreases are given as input to the system .the images are given to the ultrasound scanner and then extracted into MATLAB environment for analysis. Fig.3: shows the methodological diagram of the system.The steps are explained as given below:

The steps are explained as given below:

Image Acquisition: 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.

Image cropping and resizing: images are taken for each organ. The images then cropped into specific sizes before it is converted to grayscale.

Filtering methods applied: This section discusses about filtering techniques used in enhancement images. Five filters, median, Wiener, N-D, entropy and 2-D order statistic filter are used to filter noises from kidney, liver and pancreas images.

- Median Filter is a non-linear filter which is known as rank filtering. It is the best filtering technique in reducing salt and pepper noise while maintaining the sharp edges in an image. However, the main weakness of this filter is it cannot differentiate between noisy and non-noisy details.
- 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.
- N-D Filter: A function used to perform filtering of multidimensional images. It computes each elements of the output using double-precision floating point.
- The entropy filter is null for a flat image and increases when the data contains some information.
- 2-D Order Statistic Filter: The filter sorted pixel values over a neighbourhood, select and replaced each element in original image by kth largest value element.

Image quality analysis: Mean Square Error (MSE), Peak Signal Noise to Ratio (PSNR) will be used to analyse filtered images. 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.

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.

The highest peak signal-to-noise ratio (PSNR) gave the best performance of an image which leads to a high image quality.

Visual inspection of images is commonly measured by experts. The main weakness of this method is it is subjective analysis according to the eye of the experts.

The proposed method has following advantages and disadvantages

Advantages:

- Different filters like median, Wiener, N-D, entropy and 2-D order statistic filter are used to filter noises.
- Comparison of different filters and best fit is found.
- This provides ample information about the human soft tissue.

Disadvantage:

- Doesn't show comparison of many filters.
- Less accuracy.
- Few filters work best for few organs.

Results:

Filter Type	Cut-Off Frequency
Median Filter	F = 2

Ideal Filter	F = 50
Fourier Ideal Filter	F = 50
Wavelet Filter	F = 4
Homomorphic Fourier Ideal Filter	F = 50

The Ranges of MSE and PSNR is given in the following XL sheet

Median Filter:

A5 Median Filter

	A	B	C	D	E
1	Filter	Window	MSE	PSNR	SNR
2	Median Fil	3x3	9.47E-06	98.36608	94.04795
3	Median Fil	5x5	2.51E-05	94.13284	89.8147
4	Median Fil	7x7	5.66E-05	90.60609	86.28795
5	Median Fil	9x9	0.00012	87.35064	83.03251

Fourier Ideal Filter:

A4 Fourier Ideal Filter

	A	B	C	D	E
1	Filter	Cutoff	MSE	PSNR	SNR
2	Fourier Ide	10	0.012008	67.33626	63.22042
3	Fourier Ide	30	0.006672	69.88826	65.77241
4	Fourier Ide	40	0.005009	71.13371	67.01786
5	Fourier Ide	50	0.00396	72.15402	68.03818

Wavelet Filter:

A5 Wavelet Filter

	A	B	C	D	E	F
1	Filter	Level	Band	MSE	PSNR	SNR
2	Wavelet Fi	2	HL	0.172634	55.75954	52.87127
3	Wavelet Fi	2	LH	0.172577	55.76097	52.8727
4	Wavelet Fi	2	HH	0.174363	55.71625	52.82798
5	Wavelet Fi	2	LH-HH	0.172285	55.76833	52.88006

Homomorphic Fourier Ideal Filter:

A5 Homomorphic Fourier Ideal Filter

	A	B	C	D	E	F
1	Filter	Cutoff	MSE	PSNR	SNR	SNR
2	Homomor	10	0.027449	63.74557	55.01245	62.55046
3	Homomor	30	0.014393	66.54935	57.81623	62.01169
4	Homomor	40	0.014146	66.62455	57.89142	73.54124
5	Homomor	50	0.012694	67.09476	58.36163	62.21109

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.

Future Enhancement:

1. The project can be further improved by adding artificial intelligence so that the system can identify the type of organ and which filter best suits the image based on the quality measures.
2. More filters can be combined to get better image enhancement.
3. Can implement more performance analysis techniques for better analysis of the image.
4. The system can further be enhanced to detect the defect if any, in the input image as well.
5. Can be made fully automated so that there is no subjective analysis according to the eye of the experts. Thereby reducing the human error.

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