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Speckle Noise Reduction on Medical Ultrasound Imaging

تقليل ضوضاء الرقطة في صور الموجات فوق الصوتية

A project submitted for fulfillment of requirement for the B.Sc. (honor) degree in biomedical engineering.

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Table of contents

List of table

List of figure

Abbreviations

US	**UltraSound**
TGC	**Time Gain Compensation**
US B-mode	**Ultrasound Brightness mode**
US A-mode	**Ultrasound Amplitude mode**
US M-mode	**Ultrasound Motion mode**
ICA	**Internal Carotid Artery**
SAR	**Synthetic Aperture Radar**
FFS	**Fully Formed Speckle pattern**
NRLR	**Non Randomly distributed with Long-Range order**
NRSR	**Non Randomly distributed with Short-Range order**
PDF	**Probability Density Function**
gf4d	**Geometric Filter**
ca	**Linear scaling gray level filter**
lecasort	**Linear scaling and sorting filter**
PDE	**Partial Differential Equation**
ad	**Anisotropic Diffusion Filtering**
srad	**Reducing Anisotropic Diffusion**
DSF	**Descete Fourier Transformer**
TV	**Total Variation Filters**
ROF	**Rudin-Osher-Fatemi**
RMSE	**Root Mean Square Error**
SNR	**Signal to Noise Ratio**
PSNR	**Peak Signal to Noise Ratio**
SSIM	**Structural Similarity Index**
DWT	**Discreet Wavelet Transform**
IDWT	**Inverse Discreet Wavelet Transform**
Hrm	**Haar median technique**

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Abstract

Today, ultrasound (US) is one of the most widely used imaging technologies in medicine. It is portable, free of radiation risk, and relatively inexpensive when compared with other imaging modalities.

The ultrasound (US) B-Scan images are obtained with a simple linear or sector scan US probe, which show a granular appearance called speckle. This noise lead to degrades the target detectability and recognition and reduces the contrast , resolutions which affect the human ability to identify normal and pathological tissue.

The objective of this project is to give an overview about types of speckle reduction techniques in ultrasound imaging . And To carry out a comparative evaluation of despeckle filtering based on image quality evaluation metrics.

Anew speckle suppression methods and coherence enhancement of medical ultrasound images were proposed , combines median filter and wavelet shrinkage. It has been found that quality evaluation metrics the proposed method performs better than all other methods while still retaining the structural details and experimental results show that this method retains the edges and textures very well while removing noise.

المستخلص

اليوم،الموجات فوق الصوتيه (US) هي واحده من تقنيات التصوير الاكثر استخداما على نطاق واسع في الطب.وهي اجهزه محموله ،وخاليه من الخطر الاشعاعي ،وغير مكلفه نسبيا مقارنة مع طرائق التصوير الاخرى.

الموجات فوق الصوتيه يتم الحصول علي الصوره السطوع B-Scan images بالماسح الضوئي مع خطي بسيط ،والتي تظهر مظهر حبيبات تسمي الرقطه.وهذه الضوضاء تقود الى تقليل التباين والدقه التي تؤثر على قدره الانسان على تحديد الانسجه الطبيعيه من المرضيه.

ان الهدف من هذا المشروع هو اعطاء لمحه عامه عن انواع التقنيات التى تساعد على ازالة الرقطه في صور الموجات فوق الصوتيه.ولاجراء تققيم التقنيات على اساس مقاييس تقييم جوده الصوره.

واقتراح اساليب جديدة لازالة الرقطة وتعزيز تماسك صور الموجات فوق الصوتية الطبية، وذلك بالجمع بين المرشح المتوسط ومويجات انكماش. وقد وجد ان مقاييس تقييم الجودة تنفذ الطريقة المقترحة افضل من كل الوسائل الاخرى في حين لا يزال الابقاء على التفاصيل الهيكلية والنتائج التجريبية تبين ان هذا الاسلوب يحتفظ بالحواف و القوام جيدا اثناء ازالة الضوضاء.

Chapter One

Introduction

1.1 General review

The medical imaging devices namely X-ray, Computed Tomography/Magnetic Resonance Imaging and ultrasound are producing abundant images which are used by medical practitioners in the process of diagnosis.

The main problem faced by them is the noise introduced due to the consequence of the coherent nature of the wave transmitted. Noise is defined as unwanted signals. There are different filters to remove single type of noise such as salt and pepper, speckle noise, Gaussian noise etc. These noises corrupt the image and often lead to incorrect diagnosis. For example, the x-ray images are often corrupted by Poisson noise, while the ultrasound images are affected by Speckle noise. Speckle is a complex phenomenon, which degrades image quality with a backscattered

wave appearance which originates from many microscopic diffused reflections that passing through internal organs and makes it more difficult for the observer to discriminate fine detail of the images in diagnostic examinations. Thus, denoising or reducing these speckle noise from a noisy image has become the predominant step in medical image processing.[6]

1.2 Problem of the statement

The usefulness of ultrasound imaging is degraded by the presence of signal dependant noise known as speckle. This noise is difficult and different from other types of noise because related to the signal and should be processed and removing without affecting important image features.

1.3 Objective

Give an overview about speckle noise, how to generate, has properties, and what the effectiveness of it on the ultrasound image.

1.4 Specific objectives

1. Learning about types of speckle reduction techniques in ultrasound imaging.
2. To carry out a comparative evaluation of despeckle filtering based on image quality evaluation metrics.
3. Propose new method as a despeckle filter based on hybrid techniques.

1.5 Methodology

Images from the IBE Tech (Giza, Egypt) database of ultrasound images including liver, unborn, and GYN-abnormal-hematometra image. In the quantitative study, add speckle noise with different variance on ultrasound images and using a most importantly techniques to removing that noise.

The new technique of despeckling which based on method that applied the median filter in wavelet transformation of ultrasound image, was applied on noisy images, and then the quality evaluation metrics was found from all methods to compare the performance of those filters.

1.6 Thesis layout

The layout of this project consist of six chapters there are :chapter one include introduction and general review , while chapter two involve theoretical background ultrasound system, speckle noise and despeckle filter in chapter three, in chapter four the materials and method description , however in chapter five the results and discussion were viewed, finally chapter six is conclusion and future work.