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# **Despeckle Filtering for Ultrasound Imaging and Video**

*Volume I: Algorithms and Software*

**Second Edition**

**Christos P. Loizou**  
**Constantinos S. Pattichis**

*SYNTHESIS LECTURES ON  
ALGORITHMS AND SOFTWARE IN ENGINEERING*

*Andreas Spanias, Series Editor*

# Despeckle Filtering Algorithms And Software For Ultrasound Imaging Constantinos Pattichis

**Brian Mears, Mohit Shah**



## **Despeckle Filtering Algorithms And Software For Ultrasound Imaging Constantinos Pattichis:**

**Despeckle Filtering for Ultrasound Imaging and Video** Christos P. Loizou, Constantinos S. Pattichis, 2015-04-01 It is well known that speckle is a multiplicative noise that degrades image and video quality and the visual expert's evaluation in ultrasound imaging and video. This necessitates the need for robust despeckling image and video techniques for both routine

*Despeckle Filtering for Ultrasound Imaging and Video, Volume II* Christos P. Loizou, Constantinos S. Pattichis, 2022-06-01 In ultrasound imaging and video visual perception is hindered by speckle multiplicative noise that degrades the quality. Noise reduction is therefore essential for improving the visual observation quality or as a pre-processing step for further automated analysis such as image video segmentation texture analysis and encoding in ultrasound imaging and video. The goal of the first book (book 1 of 2 books) was to introduce the problem of speckle in ultrasound image and video as well as the theoretical background algorithmic steps and the Matlab™ for the following group of despeckle filters: linear despeckle filtering, non-linear despeckle filtering, diffusion despeckle filtering and wavelet despeckle filtering. The goal of this book (book 2 of 2 books) is to demonstrate the use of a comparative evaluation framework based on these despeckle filters introduced on book 1 on cardiovascular ultrasound image and video processing and analysis. More specifically, the despeckle filtering evaluation framework is based on texture analysis, image quality evaluation metrics and visual evaluation by experts. This framework is applied in cardiovascular ultrasound image video processing on the tasks of segmentation and structural measurements, texture analysis for differentiating between two classes (i.e. normal vs disease) and for efficient encoding for mobile applications. It is shown that despeckle noise reduction improved segmentation and measurement of tissue structure. Investigated, increased the texture feature distance between normal and abnormal tissue, improved image video quality evaluation and perception and produced significantly lower bitrates in video encoding. Furthermore, in order to facilitate further applications, we have developed in MATLAB™ two different toolboxes that integrate image IDF and video VDF despeckle filtering, texture analysis and image and video quality evaluation metrics. The code for these toolsets is open source and these are available to download complementary to the two monographs. [Despeckle Filtering for Ultrasound Imaging and Video, Volume I](#) Christos P. Loizou, Constantinos S. Pattichis, 2022-05-31 It is well known that speckle is a multiplicative noise that degrades image and video quality and the visual expert's evaluation in ultrasound imaging and video. This necessitates the need for robust despeckling image and video techniques for both routine clinical practice and teleconsultation. The goal for this book (book 1 of 2 books) is to introduce the problem of speckle occurring in ultrasound image and video as well as the theoretical background, equations, the algorithmic steps and the MATLAB™ code for the following group of despeckle filters: linear filtering, nonlinear filtering, anisotropic diffusion filtering and wavelet filtering. This book proposes a comparative evaluation framework of these despeckle filters based on texture analysis, image quality evaluation metrics and visual evaluation by medical experts. Despeckle noise reduction through the application of these filters will

improve the visual observation quality or it may be used as a pre processing step for further automated analysis such as image and video segmentation and texture characterization in ultrasound cardiovascular imaging as well as in bandwidth reduction in ultrasound video transmission for telemedicine applications The aforementioned topics will be covered in detail in the companion book to this one Furthermore in order to facilitate further applications we have developed in MATLAB<sup>TM</sup> two different toolboxes that integrate image IDF and video VDF despeckle filtering texture analysis and image and video quality evaluation metrics The code for these toolsets is open source and these are available to download complementary to the two books Table of Contents Preface Acknowledgments List of Symbols List of Abbreviations Introduction to Speckle Noise in Ultrasound Imaging and Video Basics of Evaluation Methodology Linear Despeckle Filtering Nonlinear Despeckle Filtering Diffusion Despeckle Filtering Wavelet Despeckle Filtering Evaluation of Despeckle Filtering Summary and Future Directions References Authors Biographies

**Despeckle Filtering Algorithms and Software for Ultrasound Imaging**

Christos Loizou, Constantinos Pattichis, 2022-12-06 It is well known that speckle is a multiplicative noise that degrades image quality and the visual evaluation in ultrasound imaging This necessitates the need for robust despeckling techniques for both routine clinical practice and teleconsultation The goal for this book is to introduce the theoretical background equations the algorithmic steps and the MATLAB<sup>TM</sup> code for the following group of despeckle filters linear filtering nonlinear filtering anisotropic diffusion filtering and wavelet filtering The book proposes a comparative evaluation framework of these despeckle filters based on texture analysis image quality evaluation metrics and visual evaluation by medical experts in the assessment of cardiovascular ultrasound images recorded from the carotid artery The results of our work presented in this book suggest that the linear local statistics filter DsFlsmv gave the best performance followed by the nonlinear geometric filter DsFgf4d and the linear homogeneous maskarea filter DsFlsminsc These filters improved the class separation between the asymptomatic and the symptomatic classes of ultrasound images recorded from the carotid artery for the assessment of stroke based on the statistics of the extracted texture features gave only a marginal improvement in the classification success rate and improved the visual assessment carried out by two medical experts A despeckle filtering analysis and evaluation framework is proposed for selecting the most appropriate filter or filters for the images under investigation These filters can be further developed and evaluated at a larger scale and in clinical practice in the automated image and video segmentation texture analysis and classification not only for medical ultrasound but for other modalities as well such as synthetic aperture radar SAR images Table of Contents Introduction to Ultrasound Imaging Despeckle Filtering Algorithms Evaluation Methodology Applications of Despeckle Filtering in Ultrasound Imaging Comparison and Discussion of Despeckle Filtering Algorithms Summary and Future Directions

Despeckle Filtering for Ultrasound Imaging and Video, Volume II: Selected Applications, Second Edition Christos P. Loizou, Constantinos S. Pattichis, 2015-08-01 In ultrasound imaging and video visual perception is hindered by speckle multiplicative noise that degrades the quality Noise reduction is therefore essential for

improving the visual observation quality or as a pre processing step for further automated analysis such as image video segmentation texture analysis and encoding in ultrasound imaging and video The goal of the first book book 1 of 2 books was to introduce the problem of speckle in ultrasound image and video as well as the theoretical background algorithmic steps and the MatlabTM for the following group of despeckle filters linear despeckle filtering non linear despeckle filtering diffusion despeckle filtering and wavelet despeckle filtering The goal of this book book 2 of 2 books is to demonstrate the use of a comparative evaluation framework based on these despeckle filters introduced on book 1 on cardiovascular ultrasound image and video processing and analysis More specifically the despeckle filtering evaluation framework is based on texture analysis image quality evaluation metrics and visual evaluation by experts This framework is applied in cardiovascular ultrasound image video processing on the tasks of segmentation and structural measurements texture analysis for differentiating between two classes i e normal vs disease and for efficient encoding for mobile applications It is shown that despeckle noise reduction improved segmentation and measurement of tissue structure investigated increased the texture feature distance between normal and abnormal tissue improved image video quality evaluation and perception and produced significantly lower bitrates in video encoding Furthermore in order to facilitate further applications we have developed in MATLABTM two different toolboxes that integrate image IDF and video VDF despeckle filtering texture analysis and image and video quality evaluation metrics The code for these toolsets is open source and these are available to download complementary to the two monographs *Despeckle Filtering Algorithms and Software for Ultrasound Imaging* Christos P. Loizou, Constantinos S. Pattichis, 2008 It is well known that speckle is a multiplicative noise that degrades image quality and the visual evaluation in ultrasound imaging This necessitates the need for robust despeckling techniques for both routine clinical practice and teleconsultation The goal for this book is to introduce the theoretical background equations the algorithmic steps and the MATLAB code for the following group of despeckle filters linear filtering nonlinear filtering anisotropic diffusion filtering and wavelet filtering The book proposes a comparative evaluation framework of these despeckle filters based on texture analysis image quality evaluation metrics and visual evaluation by medical experts in the assessment of cardiovascular ultrasound images recorded from the carotid artery The results of our work presented in this book suggest that the linear local statistics filter DsFlsmv gave the best performance followed by the nonlinear geometric filter DsFgf4d and the linear homogeneous mask area filter DsFlsminsc These filters improved the class separation between the asymptomatic and the symptomatic classes of ultrasound images recorded from the carotid artery for the assessment of stroke based on the statistics of the extracted texture features gave only a marginal improvement in the classification success rate and improved the visual assessment carried out by two medical experts A despeckle filtering analysis and evaluation framework is proposed for selecting the most appropriate filter or filters for the images under investigation These filters can be further developed and evaluated at a larger scale and in clinical practice in the automated image and video segmentation

texture analysis and classification not only for medical ultrasound but for other modalities as well such as synthetic aperture radar SAR images

Ultrasound and Carotid Bifurcation Atherosclerosis Andrew Nicolaides, Kirk W. Beach, Efthymou Kyriacou, Constantinos S. Pattichis, 2011-11-24 Ultrasound and Carotid Bifurcation Atherosclerosis provides a comprehensive overview of the most recent advancements in instrumentation imaging techniques including the use of contrast enhancement agents plaque image analysis and its automation elastography and plaque motion analysis also the use of ultrasonic and other biomarkers in the detection of the high risk cardiovascular individual Finally it deals with the application of IVUS TCD and carotid plaque characterization in clinical practice and in stroke risk stratification Ultrasound and Carotid Bifurcation Atherosclerosis is intended for all those working in the field of atherosclerosis ultrasound imaging and cardiovascular risk including the clinician the vascular ultrasonographer the epidemiologist the molecular biologist the biomedical engineer and the informatics scientist Furthermore this book bridges the gap between the researcher and the clinician who is keen to incorporate the latest results of research to his daily practice

Algorithms and Software for Predictive and Perceptual Modeling of Speech Venkatraman Atti, 2022-05-31 From the early pulse code modulation based coders to some of the recent multi rate wideband speech coding standards the area of speech coding made several significant strides with an objective to attain high quality of speech at the lowest possible bit rate This book presents some of the recent advances in linear prediction LP based speech analysis that employ perceptual models for narrow and wide band speech coding The LP analysis synthesis framework has been successful for speech coding because it fits well the source system paradigm for speech synthesis Limitations associated with the conventional LP have been studied extensively and several extensions to LP based analysis synthesis have been proposed e g the discrete all pole modeling the perceptual LP the warped LP the LP with modified filter structures the IIR based pure LP all pole modeling using the weighted sum of LSP polynomials the LP for low frequency emphasis and the cascade form LP These extensions can be classified as algorithms that either attempt to improve the LP spectral envelope fitting performance or embed perceptual models in the LP The first half of the book reviews some of the recent developments in predictive modeling of speech with the help of Matlab™ Simulation examples Advantages of integrating perceptual models in low bit rate speech coding depend on the accuracy of these models to mimic the human performance and more importantly on the achievable coding gains and computational overhead associated with these physiological models Methods that exploit the masking properties of the human ear in speech coding standards even today are largely based on concepts introduced by Schroeder and Atal in 1979 For example a simple approach employed in speech coding standards is to use a perceptual weighting filter to shape the quantization noise according to the masking properties of the human ear The second half of the book reviews some of the recent developments in perceptual modeling of speech e g masking threshold psychoacoustic models auditory excitation pattern and loudness with the help of Matlab™ simulations Supplementary material including Matlab™ programs and simulation examples presented in this book can also be accessed

here Table of Contents Introduction Predictive Modeling of Speech Perceptual Modeling of Speech      **MATLAB® Software for the Code Excited Linear Prediction Algorithm** Karthikeyan Ramamurthy, Andreas Spanias, 2022-05-31 This book describes several modules of the Code Excited Linear Prediction CELP algorithm The authors use the Federal Standard 1016 CELP MATLAB software to describe in detail several functions and parameter computations associated with analysis by synthesis linear prediction The book begins with a description of the basics of linear prediction followed by an overview of the FS 1016 CELP algorithm Subsequent chapters describe the various modules of the CELP algorithm in detail In each chapter an overall functional description of CELP modules is provided along with detailed illustrations of their MATLAB implementation Several code examples and plots are provided to highlight some of the key CELP concepts Link to MATLAB code found within the book Table of Contents Introduction to Linear Predictive Coding Autocorrelation Analysis and Linear Prediction Line Spectral Frequency Computation Spectral Distortion The Codebook Search The FS 1016 Decoder      **Virtual Design of an Audio Lifelogging System** Brian Mears, Mohit Shah, 2022-06-01 The availability of inexpensive custom highly integrated circuits is enabling some very powerful systems that bring together sensors smart phones wearables cloud computing and other technologies To design these types of complex systems we are advocating a top down simulation methodology to identify problems early This approach enables software development to start prior to expensive chip and hardware development We call the overall approach virtual design This book explains why simulation has become important for chip design and provides an introduction to some of the simulation methods used The audio lifelogging research project demonstrates the virtual design process in practice The goals of this book are to explain how silicon design has become more closely involved with system design show how virtual design enables top down design explain the utility of simulation at different abstraction levels show how open source simulation software was used in audio lifelogging The target audience for this book are faculty engineers and students who are interested in developing digital devices for Internet of Things IoT types of products

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