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Digital Speech Transmission

Enhancement, Coding and Error Concealment

 WILEY

Digital Speech Transmission Enhancement Coding And Error Concealment

**Emmanuel Vincent, Tuomas
Virtanen, Sharon Gannot**



Digital Speech Transmission Enhancement Coding And Error Concealment:

Digital Speech Transmission Peter Vary, Rainer Martin, 2006-08-04 The enormous advances in digital signal processing DSP technology have contributed to the wide dissemination and success of speech communication devices be it GSM and UMTS mobile telephones digital hearing aids or human machine interfaces Digital speech transmission techniques play an important role in these applications all the more because high quality speech transmission remains essential in all current and next generation communication networks Enhancement coding and error concealment techniques improve the transmitted speech signal at all stages of the transmission chain from the acoustic front end to the sound reproduction at the receiver Advanced speech processing algorithms help to mitigate a number of physical and technological limitations such as background noise bandwidth restrictions shortage of radio frequencies and transmission errors Digital Speech Transmission provides a single source comprehensive guide to the fundamental issues algorithms standards and trends in speech signal processing and speech communication technology The authors give a solid accessible overview of fundamentals of speech signal processing speech coding including new speech coders for GSM and UMTS error concealment by soft decoding artificial bandwidth extension of speech signals single and multi channel noise reduction acoustic echo cancellation This text is an invaluable resource for engineers researchers academics and graduate students in the areas of communications electrical engineering and information technology

Digital Speech Transmission and Enhancement Peter Vary, Rainer Martin, 2023-11-29 DIGITAL SPEECH TRANSMISSION AND ENHANCEMENT Enables readers to understand the latest developments in speech enhancement transmission due to advances in computational power and device miniaturization The Second Edition of Digital Speech Transmission and Enhancement has been updated throughout to provide all the necessary details on the latest advances in the theory and practice in speech signal processing and its applications including many new research results standards algorithms and developments which have recently appeared and are on their way into state of the art applications Besides mobile communications which constituted the main application domain of the first edition speech enhancement for hearing instruments and man machine interfaces has gained significantly more prominence in the past decade and as such receives greater focus in this updated and expanded second edition Readers can expect to find information and novel methods on Low latency spectral analysis synthesis single channel and dual channel algorithms for noise reduction and dereverberation Multi microphone processing methods which are now widely used in applications such as mobile phones hearing aids and man computer interfaces Algorithms for near end listening enhancement which provide a significantly increased speech intelligibility for users at the noisy receiving side of their mobile phone Fundamentals of speech signal processing estimation and machine learning speech coding error concealment by soft decoding and artificial bandwidth extension of speech signals Digital Speech Transmission and Enhancement is a single source comprehensive guide to the fundamental issues algorithms standards and trends in speech signal processing and speech communication

technology and as such is an invaluable resource for engineers researchers academics and graduate students in the areas of communications electrical engineering and information technology

Advances in Digital Speech Transmission Prof Rainer Martin, Prof Ulrich Heute, Prof Christiane Antweiler, 2008-02-28 Speech processing and speech transmission technology are expanding fields of active research New challenges arise from the anywhere anytime paradigm of mobile communications the ubiquitous use of voice communication systems in noisy environments and the convergence of communication networks toward Internet based transmission protocols such as Voice over IP As a consequence new speech coding new enhancement and error concealment and new quality assessment methods are emerging Advances in Digital Speech Transmission provides an up to date overview of the field including topics such as speech coding in heterogeneous communication networks wideband coding and the quality assessment of wideband speech Provides an insight into the latest developments in speech processing and speech transmission making it an essential reference to those working in these fields Offers a balanced overview of technology and applications Discusses topics such as speech coding in heterogeneous communications networks wideband coding and the quality assessment of the wideband speech Explains speech signal processing in hearing instruments and man machine interfaces from applications point of view Covers speech coding for Voice over IP blind source separation digital hearing aids and speech processing for automatic speech recognition Advances in Digital Speech Transmission serves as an essential link between the basics and the type of technology and applications prospective engineers work on in industry labs and academia The book will also be of interest to advanced students researchers and other professionals who need to brush up their knowledge in this field

Speech Enhancement Philipos C. Loizou, 2013-02-25 With the proliferation of mobile devices and hearing devices including hearing aids and cochlear implants there is a growing and pressing need to design algorithms that can improve speech intelligibility without sacrificing quality Responding to this need Speech Enhancement Theory and Practice Second Edition introduces readers to the basic principles of speech enhancement

A Perspective on Single-Channel Frequency-Domain Speech Enhancement Jacob Benesty, Yiteng Huang, 2022-05-31 This book focuses on a class of single channel noise reduction methods that are performed in the frequency domain via the short time Fourier transform STFT The simplicity and relative effectiveness of this class of approaches make them the dominant choice in practical systems Even though many popular algorithms have been proposed through more than four decades of continuous research there are a number of critical areas where our understanding and capabilities still remain quite rudimentary especially with respect to the relationship between noise reduction and speech distortion All existing frequency domain algorithms no matter how they are developed have one feature in common the solution is eventually expressed as a gain function applied to the STFT of the noisy signal only in the current frame As a result the narrowband signal to noise ratio SNR cannot be improved and any gains achieved in noise reduction on the fullband basis come with a price to pay which is speech distortion In this book we present a new perspective on the problem by exploiting the difference between

speech and typical noise in circularity and interframe self correlation which were ignored in the past By gathering the STFT of the microphone signal of the current frame its complex conjugate and the STFTs in the previous frames we construct several new multiple observation signal models similar to a microphone array system there are multiple noisy speech observations and their speech components are correlated but not completely coherent while their noise components are presumably uncorrelated Therefore the multichannel Wiener filter and the minimum variance distortionless response MVDR filter that were usually associated with microphone arrays will be developed for single channel noise reduction in this book This might instigate a paradigm shift geared toward speech distortionless noise reduction techniques

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Speech Enhancement in the STFT Domain Jacob Benesty, Jingdong Chen, Emanuël A.P. Habets, 2011-09-18 This work addresses this problem in the short time Fourier transform STFT domain We divide the general problem into five basic categories depending on the number of microphones being used and whether the interframe or interband correlation is considered The first category deals with the single channel problem where STFT coefficients at different frames and frequency bands are assumed to be independent In this case the noise reduction filter in each frequency band is basically a real gain Since a gain does not improve the signal to noise ratio SNR for any given subband and frame the noise reduction is basically achieved by liftering the subbands and frames that are less noisy while weighing down on those that are more noisy The second category also concerns the single channel problem The difference is that now the interframe correlation is taken into account and a filter is applied in each subband instead of just a gain The advantage of using the interframe correlation is that we can improve not only the long time fullband SNR but the frame wise subband SNR as well The third and fourth classes discuss the problem of multichannel noise reduction in the STFT domain with and without interframe correlation respectively In the last category we consider the interband correlation in the design of the noise reduction filters We illustrate the basic principle for the single channel case as an example while this concept can be generalized to other scenarios In all categories we propose different optimization cost functions from which we derive the optimal filters and we also define the performance measures that help analyzing them

Speech Enhancement in the Karhunen-Loeve Expansion Domain Jacob Benesty, Jingdong Chen, Yiteng Huang, 2022-05-31 This book is devoted to the study of the problem of speech enhancement whose objective is the recovery of a signal of interest i.e speech from noisy observations Typically the recovery process is accomplished by passing the noisy observations through a linear filter or a linear transformation Since both the desired speech and undesired noise are filtered at the same time the most critical issue of speech enhancement resides in how to design a proper optimal filter that can fully take advantage of the difference between the speech and noise statistics to mitigate the noise effect as much as possible while maintaining the speech perception identical to its original form The

optimal filters can be designed either in the time domain or in a transform space As the title indicates this book will focus on developing and analyzing optimal filters in the Karhunen Lo ve expansion KLE domain We begin by describing the basic problem of speech enhancement and the fundamental principles to solve it in the time domain We then explain how the problem can be equivalently formulated in the KLE domain Next we divide the general problem in the KLE domain into four groups depending on whether interframe and interband information is accounted for leading to four linear models for speech enhancement in the KLE domain For each model we introduce signal processing measures to quantify the performance of speech enhancement discuss the formation of different cost functions and address the optimization of these cost functions for the derivation of different optimal filters Both theoretical analysis and experiments will be provided to study the performance of these filters and the links between the KLE domain and time domain optimal filters will be examined Table of Contents Introduction Problem Formulation Optimal Filters in the Time Domain Linear Models for Signal Enhancement in the KLE Domain Optimal Filters in the KLE Domain with Model 1 Optimal Filters in the KLE Domain with Model 2 Optimal Filters in the KLE Domain with Model 3 Optimal Filters in the KLE Domain with Model 4 Experimental Study

Fundamentals of Speech Enhancement Jacob Benesty, 2018-02-09 This book presents and develops several important concepts of speech enhancement in a simple but rigorous way Many of the ideas are new not only do they shed light on this old problem but they also offer valuable tips on how to improve on some well known conventional approaches The book unifies all aspects of speech enhancement from single channel multichannel beamforming time domain frequency domain and time frequency domain to binaural in a clear and flexible framework It starts with an exhaustive discussion on the fundamental best linear and nonlinear estimators showing how they are connected to various important measures such as the coefficient of determination the correlation coefficient the conditional correlation coefficient and the signal to noise ratio SNR It then goes on to show how to exploit these measures in order to derive all kinds of noise reduction algorithms that can offer an accurate and versatile compromise between noise reduction and speech distortion

Sound Capture and Processing Ivan Jelev Tashev, 2009-07-01 Provides state of the art algorithms for sound capture processing and enhancement Sound Capture and Processing Practical Approaches covers the digital signal processing algorithms and devices for capturing sounds mostly human speech It explores the devices and technologies used to capture enhance and process sound for the needs of communication and speech recognition in modern computers and communication devices This book gives a comprehensive introduction to basic acoustics and microphones with coverage of algorithms for noise reduction acoustic echo cancellation dereverberation and microphone arrays charting the progress of such technologies from their evolution to present day standard Sound Capture and Processing Practical Approaches Brings together the state of the art algorithms for sound capture processing and enhancement in one easily accessible volume Provides invaluable implementation techniques required to process algorithms for real life applications and devices Covers a number of advanced sound processing

techniques such as multichannel acoustic echo cancellation dereverberation and source separation. Generously illustrated with figures and charts to demonstrate how sound capture and audio processing systems work. An accompanying website containing Matlab code to illustrate the algorithms. This invaluable guide will provide audio R D and software engineers in the industry of building systems or computer peripherals for speech enhancement with a comprehensive overview of the technologies, devices and algorithms required for modern computers and communication devices. Graduate students studying electrical engineering and computer science and researchers in multimedia, cell phones, interactive systems and acousticians will also benefit from this book. Audio Source Separation and Speech Enhancement Emmanuel Vincent, Tuomas

Virtanen, Sharon Gannot, 2018-07-24. Learn the technology behind hearing aids, Siri and Echo. Audio source separation and speech enhancement aim to extract one or more source signals of interest from an audio recording involving several sound sources. These technologies are among the most studied in audio signal processing today and bear a critical role in the success of hearing aids, hands free phones, voice command and other noise robust audio analysis systems and music post production software. Research on this topic has followed three convergent paths starting with sensor array processing, computational auditory scene analysis and machine learning based approaches such as independent component analysis respectively. This book is the first one to provide a comprehensive overview by presenting the common foundations and the differences between these techniques in a unified setting. Key features: Consolidated perspective on audio source separation and speech enhancement. Both historical perspective and latest advances in the field, e.g. deep neural networks. Diverse disciplines: array processing, machine learning and statistical signal processing. Covers the most important techniques for both single channel and multichannel processing. This book provides both introductory and advanced material suitable for people with basic knowledge of signal processing and machine learning. Thanks to its comprehensiveness, it will help students select a promising research track, researchers leverage the acquired cross domain knowledge to design improved techniques and engineers and developers choose the right technology for their target application scenario. It will also be useful for practitioners from other fields, e.g. acoustics, multimedia, phonetics and musicology, willing to exploit audio source separation or speech enhancement as pre processing tools for their own needs. **Starting Digital Signal Processing in**

Telecommunication Engineering Tomasz P. Zielinski, 2021-01-29. This hands on laboratory driven textbook helps readers understand principles of digital signal processing, DSP and basics of software based digital communication, particularly software defined networks, SDN and software defined radio, SDR. In the book, only the most important concepts are presented. Each book chapter is an introduction to computer laboratory and is accompanied by complete laboratory exercises and ready to go Matlab programs with figures and comments available at the book webpage and running also in GNU Octave 5.2 with free software packages showing all or most details of relevant algorithms. Students are tasked to understand programs, modify them and apply presented concepts to recorded real RF signal or simulated received signals with modelled

transmission condition and hardware imperfections Teaching is done by showing examples and their modifications to different real world telecommunication like applications The book consists of three parts introduction to DSP spectral analysis and digital filtering introduction to DSP advanced topics multi rate adaptive model based and multimedia speech audio video signal analysis and processing and introduction to software defined modern telecommunication systems SDR technology analog and digital modulations single and multi carrier systems channel estimation and correction as well as synchronization issues Many real signals are processed in the book in the first part mainly speech and audio while in the second part mainly RF recordings taken from RTL SDR USB stick and ADALM PLUTO module for example captured IQ data of VOR avionics signal classical FM radio with RDS digital DAB DAB radio and 4G LTE digital telephony Additionally modelling and simulation of some transmission scenarios are tested in software in the book in particular TETRA ADSL and 5G signals Provides an introduction to digital signal processing and software based digital communication Presents a transition from digital signal processing to software defined telecommunication Features a suite of pedagogical materials including a laboratory test bed and computer exercises experiments

Fundamentals of Signal Enhancement and Array Signal Processing Jacob Benesty, Israel Cohen, Jingdong Chen, 2017-12-18 A comprehensive guide to the theory and practice of signal enhancement and array signal processing including matlab codes exercises and instructor and solution manuals

Systematically introduces the fundamental principles theory and applications of signal enhancement and array signal processing in an accessible manner Offers an updated and relevant treatment of array signal processing with rigor and concision Features a companion website that includes presentation files with lecture notes homework exercises course projects solution manuals instructor manuals and Matlab codes for the examples in the book

[Signal Enhancement with Variable Span Linear Filters](#) Jacob Benesty, Mads G. Christensen, Jesper R. Jensen, 2016-02-05 This book introduces readers to the novel concept of variable span speech enhancement filters and demonstrates how it can be used for effective noise reduction in various ways Further the book provides the accompanying Matlab code allowing readers to easily implement the main ideas discussed Variable span filters combine the ideas of optimal linear filters with those of subspace methods as they involve the joint diagonalization of the correlation matrices of the desired signal and the noise The book shows how some well known filter designs e g the minimum distortion maximum signal to noise ratio Wiener and tradeoff filters including their new generalizations can be obtained using the variable span filter framework It then illustrates how the variable span filters can be applied in various contexts namely in single channel STFT based enhancement in multichannel enhancement in both the time and STFT domains and lastly in time domain binaural enhancement In these contexts the properties of these filters are analyzed in terms of their noise reduction capabilities and desired signal distortion and the analyses are validated and further explored in simulations

Digital Audio Signal Processing Udo Zölzer, 2022-02-24 Digital Audio Signal Processing The fully revised new edition of the popular textbook featuring additional MATLAB exercises and new algorithms

for processing digital audio signals Digital Audio Signal Processing DASP techniques are used in a variety of applications ranging from audio streaming and computer generated music to real time signal processing and virtual sound processing Digital Audio Signal Processing provides clear and accessible coverage of the fundamental principles and practical applications of digital audio processing and coding Throughout the book the authors explain a wide range of basic audio processing techniques and highlight new directions for automatic tuning of different algorithms and discuss state of the art DASP approaches Now in its third edition this popular guide is fully updated with the latest signal processing algorithms for audio processing Entirely new chapters cover nonlinear processing Machine Learning ML for audio applications distortion soft hard clipping overdrive equalizers and delay effects sampling and reconstruction and more Covers the fundamentals of quantization filters dynamic range control room simulation sampling rate conversion and audio coding Describes DASP techniques their theoretical foundations and their practical applications Discusses modern studio technology digital transmission systems storage media and home entertainment audio components Features a new introductory chapter and extensively revised content throughout Provides updated application examples and computer based activities supported with MATLAB exercises and interactive JavaScript applets via an author hosted companion website Balancing essential concepts and technological topics Digital Audio Signal Processing Third Edition remains the ideal textbook for advanced music technology and engineering students in audio signal processing courses It is also an invaluable reference for audio engineers hardware and software developers and researchers in both academia and industry

Adaptive Signal Processing Tülay Adalı, Simon Haykin, 2010-06-25 Leading experts present the latest research results in adaptive signal processing Recent developments in signal processing have made it clear that significant performance gains can be achieved beyond those achievable using standard adaptive filtering approaches Adaptive Signal Processing presents the next generation of algorithms that will produce these desired results with an emphasis on important applications and theoretical advancements This highly unique resource brings together leading authorities in the field writing on the key topics of significance each at the cutting edge of its own area of specialty It begins by addressing the problem of optimization in the complex domain fully developing a framework that enables taking full advantage of the power of complex valued processing Then the challenges of multichannel processing of complex valued signals are explored This comprehensive volume goes on to cover Turbo processing tracking in the subspace domain nonlinear sequential state estimation and speech bandwidth extension Examines the seven most important topics in adaptive filtering that will define the next generation adaptive filtering solutions Introduces the powerful adaptive signal processing methods developed within the last ten years to account for the characteristics of real life data non Gaussianity non circularity non stationarity and non linearity Features self contained chapters numerous examples to clarify concepts and end of chapter problems to reinforce understanding of the material Contains contributions from acknowledged leaders in the field Adaptive Signal Processing is an invaluable tool for graduate

students researchers and practitioners working in the areas of signal processing communications controls radar sonar and biomedical engineering

Single Channel Phase-Aware Signal Processing in Speech Communication Pejman Mowlaei, Josef Kulmer, Johannes Stahl, Florian Mayer, 2016-12-27 An overview on the challenging new topic of phase aware signal processing Speech communication technology is a key factor in human machine interaction digital hearing aids mobile telephony and automatic speech speaker recognition With the proliferation of these applications there is a growing requirement for advanced methodologies that can push the limits of the conventional solutions relying on processing the signal magnitude spectrum Single Channel Phase Aware Signal Processing in Speech Communication provides a comprehensive guide to phase signal processing and reviews the history of phase importance in the literature basic problems in phase processing fundamentals of phase estimation together with several applications to demonstrate the usefulness of phase processing Key features Analysis of recent advances demonstrating the positive impact of phase based processing in pushing the limits of conventional methods Offers unique coverage of the historical context fundamentals of phase processing and provides several examples in speech communication Provides a detailed review of many references and discusses the existing signal processing techniques required to deal with phase information in different applications involved with speech The book supplies various examples and MATLAB implementations delivered within the PhaseLab toolbox Single Channel Phase Aware Signal Processing in Speech Communication is a valuable single source for students non expert DSP engineers academics and graduate students

Speech and Audio Processing in Adverse Environments Eberhard Hänsler, Gerhard Schmidt, 2008-07-22 Users of signal processing systems are never satisfied with the system they currently use They are constantly asking for higher quality faster performance more comfort and lower prices Researchers and developers should be appreciative for this attitude It justifies their constant effort for improved systems Better knowledge about biological and physical interrelations coming along with more powerful technologies are their engines on the endless road to perfect systems This book is an impressive image of this process After Acoustic Echo 1 and Noise Control published in 2004 many new results lead to Topics in 2 Acoustic Echo and Noise Control edited in 2006 Today in 2008 even more new findings and systems could be collected in this book Comparing the contributions in both edited volumes progress in knowledge and technology becomes clearly visible Blind methods and multi input systems replace the low complexity systems The functionality of new systems is less and less limited by the processing power available under economic constraints The editors have to thank all the authors for their contributions They cooperated readily in our effort to unify the layout of the chapters the terminology and the symbols used It was a pleasure to work with all of them Furthermore it is the editors concern to thank Christoph Baumann and the Springer Publishing Company for the encouragement and help in publishing this book

Multimedia Computing Gerald Friedland, Ramesh Jain, 2014-07-28 This innovative textbook presents an experiential holistic approach to multimedia computing along with practical algorithms

Techniques for Noise Robustness in

Automatic Speech Recognition Tuomas Virtanen, Rita Singh, Bhiksha Raj, 2012-11-28 Automatic speech recognition ASR systems are finding increasing use in everyday life. Many of the commonplace environments where the systems are used are noisy; for example, users calling up a voice search system from a busy cafeteria or a street. This can result in degraded speech recordings and adversely affect the performance of speech recognition systems. As the use of ASR systems increases, knowledge of the state of the art in techniques to deal with such problems becomes critical to system and application engineers and researchers who work with or on ASR technologies. This book presents a comprehensive survey of the state of the art in techniques used to improve the robustness of speech recognition systems to these degrading external influences. Key features: Reviews all the main noise robust ASR approaches including signal separation, voice activity detection, robust feature extraction, model compensation and adaptation, missing data techniques, and recognition of reverberant speech. Acts as a timely exposition of the topic in light of more widespread use in the future of ASR technology in challenging environments. Addresses robustness issues and signal degradation, which are both key requirements for practitioners of ASR. Includes contributions from top ASR researchers from leading research units in the field. **Towards Human-Vehicle Harmonization** Huseyin Abut, Gerhard Schmidt, Kazuya Takeda, Jacob Lambert, John H.L. Hansen, 2023-03-20 This book features works from world class experts from academia, industry and national agencies focusing on a wide spectrum of automotive fields towards human-vehicle harmonization, covering in-vehicle signal processing, driver modeling, systems and safety. The essays collected in this volume present cutting edge studies on safety, driver behavior, infrastructure and human to vehicle interfaces.

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