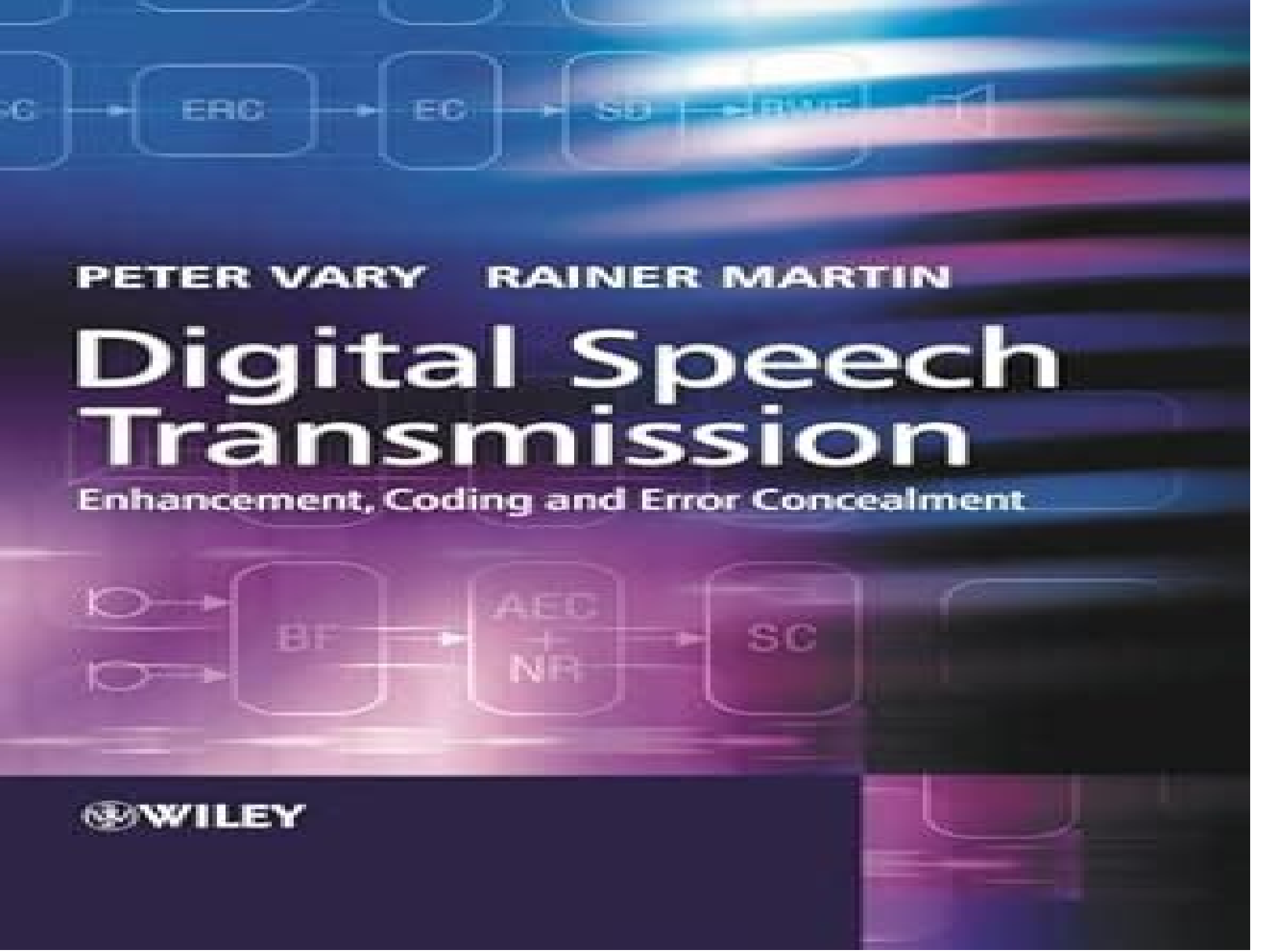




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# Digital Speech Transmission

Enhancement, Coding and Error Concealment

 WILEY

# Digital Speech Transmission Enhancement Coding And Error Concealment

**Jacob Benesty, Jingdong Chen, Emanuel  
A.P. Habets**



## **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 **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 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. *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, Emanuel 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-Loeve 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. Zieliński,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



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