Blind Channel Identi®cation and Equalization for GI-less OFDM Systems

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Abstract⏤ We introduce blind channel identi®cation and equalization for orthogonal frequency division multiplexing (OFDM) system without using a guard interval (GI). Inter-symbol-interference (ISI) is signi®cantly reduced by truncation method. To perform channel identi®cation, Subspace and Maximum Likelihood methods are proposed. To achieve enhanced performance and robustness to channel frequency nulls, receiver diversity and OFDM is combined. The performance of the proposed system is illustrated by computer simulations.

Index Terms: OFDM, channel identi®cation, equalization, GI-less.

I. INTRODUCTION

Orthogonal Frequency Division Multiplexing (OFDM) is a multi-carrier digital modulation technique that facilitates the transmission of high data rates with a limited bandwidth [14], [15]. It is an effective technique for several applications such Digital Audio Broadcasting (DAB) and terrestrial Digital Video Broadcasting (DVB) [13]. In addition, OFDM forms the basis for the physical layer in upcoming standards for broadband Wireless Local Area Network (WLAN) [10], i.e. ESTI-BRAN HiperLAN/2 [8], IEEE 802.11a and Multimedia Mobile Access Communication Systems (MMAC) and for Fourth Generation (4G) broadband wireless systems that will perform multi-media transmission to mobiles and portable personal communications devices, i.e. European MEMO project and for IEEE 802.16.

Due to the increase in the delay spread, multipath fading has become a major concern as systems with high data rate are more liable to Inter-symbol-interference (ISI). Classically, ISI is eliminated by employing a cyclically extended time domain guard interval (GI). Thus, each OFDM symbol is preceeded by a periodic extension of the symbol itself. This GI is also known as cyclic pre®x (CP) and the system CP-OFDM [4]. Recently, zero-padding OFDM (ZP-OFDM), which pre-pends each OFDM symbol with zeros rather than replicating the last few samples, has been proposed [3], [4]. ZP-OFDM not only has all the advantages of CP-OFDM, but also guarantees symbol recovery and ensures ®nite impulse response (FIR) equalization. However, the implementation of a ZP-OFDM system involves transmitter modi®cations and complicates the equalizer.

However, due to extra symbols required by the GI, the OFDM spectrum is underutilized. This overhead can be signi®cant for channels for short latency OFDM systems. For example, in wireless ATM network demonstrator (WAND), one of the projects is HiperLAN [8], the efficiency of bandwidth usage is only 66.67%, indicating a signi®cant loss in utilization.

In this paper, we develop blind channel identi®cation and equalization for GI-less OFDM system, which do not use a CP (or GI). The channel identi®cation are developed based on Subspace (SS) [11], [1] and Maximum Likelihood (ML) techniques [9], [7], [5].

Some notations are used throughout the paper. Superscripts ^{T} and ^{H} stand for transpose operator and Hermitian operator, respectively and $*$ stands for linear convolution.
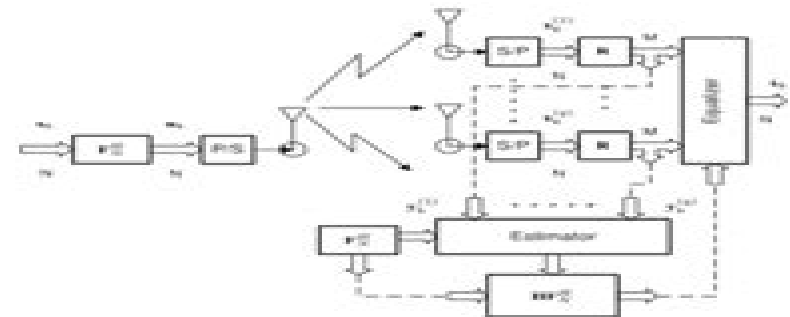
II. DATA MODEL

Fig. 1. GI-less OFDM system: transmitter and receiver.

Figure 1 shows the concept of the proposed OFDM-based SIMO system whose transmitter has single antenna and receiver has multiple antennas. In a baseband GI-less based SIMO system, the transmitted symbols are parsed into blocks: $\mathbf{s}_k = [s_k(0), s_k(1), \ldots, s_k(N-1)]^T$, where $k = 1, 2, \ldots, K$. The elements of $\mathbf{s}_k$ are considered to be independent and identically distributed (i.i.d). We regard these elements to be in the frequency domain. We assume perfect synchronization between symbols. The symbol block $\mathbf{s}_k$ is then modulated and converted into the time domain by the IFFT matrix $\mathbf{F}_N^H$, where $\mathbf{F}_N = [\mathbf{f}_0, \ldots, \mathbf{f}_{N-1}]^T$ stands for the size $(N \times N)$ with entries $f_{n,k} = \frac{1}{\sqrt{N}} \exp(\frac{j2\pi nk}{N})$ where $k, n = 0, \ldots, N-1$.

Let $\mathbf{H}_l$ be the $qN \times N$ block lower triangular Toeplitz matrix with ®rst block-column $[\mathbf{h}^T(0), \ldots, \mathbf{h}^T(L), \mathbf{0}^T, \ldots, \mathbf{0}^T]^T$ and $\mathbf{H}_u$ be the $qN \times N$ block-upper triangular Toeplitz matrix with ®rst block-row $[\mathbf{0}, \ldots, \mathbf{0}, \mathbf{h}(L), \ldots, \mathbf{h}(1)]$. For later reference, we define $M = N - L$, $n = qN$, $m = qM$, $\Lambda = qL$, and $\theta = q(L+1)$. Then, in a noisy environment the relation between the transmitted and the

Blind Channel Equalization And Identification

Patricia Melin,Oscar Castillo,Eduardo G. Ramírez,Witold Pedrycz

Blind Channel Equalization And Identification:

Blind Equalization and Identification Zhi Ding,Ye Li,2018-10-08 This text seeks to clarify various contradictory claims regarding capabilities and limitations of blind equalization It highlights basic operating conditions and potential for malfunction The authors also address concepts and principles of blind algorithms for single input multiple output SIMO systems and multi user extensions of SIMO equalization and identification **Blind Channel Estimation and Equalization for Temporally-correlated Constant-modulus Signals** Shawn Patrick Neugebauer,2003 **Nonlinear Signal and Image Processing** Kenneth E. Barner,Gonzalo R. Arce,2003-11-24 Nonlinear signal and image processing methods are fast emerging as an alternative to established linear methods for meeting the challenges of increasingly sophisticated applications Advances in computing performance and nonlinear theory are making nonlinear techniques not only viable but practical This book details recent advances in nonl *Academic Press Library in Signal Processing* Fulvio Gini,Nikolaos D. Sidiropoulos,2013-09-10 This second volume edited and authored by world leading experts gives a review of the principles methods and techniques of important and emerging research topics and technologies in communications and radar engineering With this reference source you will Quickly grasp a new area of research Understand the underlying principles of a topic and its application Ascertain how a topic relates to other areas and learn of the research issues yet to be resolved Quick tutorial reviews of important and emerging topics of research in array and statistical signal processing Presents core principles and shows their application Reference content on core principles technologies algorithms and applications Comprehensive references to journal articles and other literature on which to build further more specific and detailed knowledge Edited by leading people in the field who through their reputation have been able to commission experts to write on a particular topic Proceedings of the Second International Conference on Active Media Technology, Chongqing, PR China, 29-31 May 2003 Jian Ping Li,Jiming Liu,Ning Zhong,2003 This book captures the essence of the current state of research in active media technology and identifies the new changes and opportunities both current and future in the field Distinguished researchers such as Prof Ning Zhong from the Maebashi Institute of Technology Prof John Yen from the Pennsylvania State University and Prof Sanker K Pal from the Indian Statistical Institute present their research papers The Digital Signal Processing Handbook VIJAY MADISETTI,1997-12-29 The field of digital signal processing DSP has spurred developments from basic theory of discrete time signals and processing tools to diverse applications in telecommunications speech and acoustics radar and video This volume provides an accessible reference offering theoretical and practical information to the audience of DSP users This immense compilation outlines both introductory and specialized aspects of information bearing signals in digital form creating a resource relevant to the expanding needs of the engineering community It also explores the use of computers and special purpose digital hardware in extracting information or transforming signals in advantageous ways Impacted areas presented include Telecommunications Computer engineering

Acoustics Seismic data analysis DSP software and hardware Image and video processing Remote sensing Multimedia applications Medical technology Radar and sonar applications This authoritative collaboration written by the foremost researchers and practitioners in their fields comprehensively presents the range of DSP from theory to application from algorithms to hardware   Trends in Neural Computation Ke Chen,Lipo Wang,2006-11-15 Nowadays neural computation has become an interdisciplinary field in its own right researches have been conducted ranging from diverse disciplines e g computational neuroscience and cognitive science mathematics physics computer science and other engineering disciplines From different perspectives neural computation provides an alternative methodology to understand brain functions and cognitive process and to solve challenging real world problems effectively Trends in Neural Computation includes twenty chapters either contributed from leading experts or formed by extending well selected papers presented in the 2005 International Conference on Natural Computation The edited book aims to reflect the latest progresses made in different areas of neural computation including theoretical neural computation biologically plausible neural modeling computational cognitive science artificial neural networks architectures and learning algorithms and their applications in real world problems   Smart Antennas Thomas Kaiser,2005 Smart Antennas State of the Art brings together the broad expertise of 41 European experts in smart antennas They provide a comprehensive review and an extensive analysis of the recent progress and new results generated during the last years in almost all fields of smart antennas and MIMO multiple input multiple output transmission The following represents a summarized table of content Receiver space time processing antenna combining reduced rank processing robust beamforming subspace methods synchronization equalization multiuser detection iterative methods Channel propagation measurements and sounding modelling channel estimation direction of arrival estimation subscriber location estimation Transmitter space time block coding channel side information unified design of linear transceivers ill conditioned channels MIMO MAC strategies Network Theory channel capacity network capacity multihop networks Technology antenna design transceivers demonstrators and testbeds future air interfaces Applications and Systems 3G system and link level aspects MIMO HSDPA MIMO WLAN UMTS implementation issues This book serves as a reference for scientists and engineers who need to be aware of the leading edge research in multiple antenna communications an essential technology for emerging broadband wireless systems   *Audio Source Separation and Speech Enhancement* Emmanuel Vincent,Tuomas Virtanen,Sharon Gannot,2018-10-22 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

Wireless Communication Signals Huseyin Arslan,2021-05-04 WIRELESS COMMUNICATION SIGNALS A practical guide to wireless communication systems and concepts Wireless technologies and services have evolved significantly over the last couple of decades and Wireless Communication Signals offers an important guide to the most recent advances in wireless communication systems and concepts grounded in a practical and laboratory perspective Written by a noted expert on the topic the book provides the information needed to model simulate test and analyze wireless system and wireless circuits using modern instrumentation and computer aided design software Designed as a practical resource the book provides a clear understanding of the basic theory software simulation hardware test and modeling system component testing software and hardware interactions and co simulations This important book Provides organic and harmonized coverage of wireless communication systems Covers a range of systems from radio hardware to digital baseband signal processing Presents information on testing and measurement of wireless communication systems and subsystems Includes MATLAB file codes Written for professionals in the communications industry technical managers and researchers in both academia and industry Wireless Communication Signals introduces wireless communication systems and concepts from both a practical and laboratory perspective *Handbook of Smart Antennas for RFID Systems* Nemai Chandra Karmakar,2011-02-25 The Handbook of Smart Antennas for RFID Systems is a single comprehensive reference on the smart antenna technologies applied to RFID This book will provide a timely reference book for researchers and students in the areas of both smart antennas and RFID technologies It is the first book to combine two of the most important wireless technologies together in one book The handbook will feature chapters by leading experts in both academia and industry offering an in depth description of terminologies and concepts related to smart antennas in various RFID systems applications Some topics are adaptive beamforming for RFID smart antennas multiuser interference suppression in RFID tag reading phased array antennas for RFID applications smart antennas in wireless systems and market analysis and case

studies of RFID smart antennas This handbook will cover the latest achievements in the designs and applications for smart antennas for RFID as well as the basic concepts terms protocols systems architectures and case studies in smart antennas for RFID readers and tags **Principles of Signal Detection and Parameter Estimation** Bernard C. Levy,2008-12-16 Asadiscipline signaldetectionhasevolvedsigni cantlyoverthelast40years Some changes have been caused by technical advances like the development of robust detection methods or the use of the theory of large deviations to characterize the asymptotic performance of tests but most changes have been caused by transformations in the engineering systems to which detection te niques are applied While early applications of signal detection focused on radar and sonar signal processing or the design of digital communication ceivers newer areas of application include image analysis and interpretation document authenti cation biometrics and sensor or actuator failure det tion This expanded scope of application has required some adjustment in standardwaysofformulatingdetectionproblems Forexample imageproce ing applications typically combine parameter estimation and detection tasks so the separation of parameter estimation and detection in distinct operations typical of early communication systems where parameter estimation was complished through the use of training signals needs to be abandoned Other changes have occured in the design of communication systems which make it increasingly di cult to treat the detection of communications signals and of radar sonar signals in a uni ed manner This common framework assumes implicitly that intersymbol interference is not present and that channel c ing and modulation are implemented separately since in this case modulated signals can be detected one symbol at a time But modern communication systems are typically designed to operate over bandlimited channels where tersymbol interference is present and starting with the introduction of trellis coded modulation modulation and coding have become intertwined Proceedings of the 15th International Conference on Soft Computing and Pattern Recognition (SoCPaR 2023) Anu Bajaj, **Digital Signal Processing Fundamentals** Vijay Madisetti,2017-12-19 Now available in a three volume set this updated and expanded edition of the bestselling The Digital Signal Processing Handbook continues to provide the engineering community with authoritative coverage of the fundamental and specialized aspects of information bearing signals in digital form Encompassing essential background material technical details standards and software the second edition reflects cutting edge information on signal processing algorithms and protocols related to speech audio multimedia and video processing technology associated with standards ranging from WiMax to MP3 audio low power high performance DSPs color image processing and chips on video Drawing on the experience of leading engineers researchers and scholars the three volume set contains 29 new chapters that address multimedia and Internet technologies tomography radar systems architecture standards and future applications in speech acoustics video radar and telecommunications Emphasizing theoretical concepts Digital Signal Processing Fundamentals provides comprehensive coverage of the basic foundations of DSP and includes the following parts Signals and Systems Signal Representation and Quantization Fourier Transforms Digital Filtering Statistical

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,1997

Blind Channel Equalization And Identification Book Review: Unveiling the Magic of Language

In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has be more apparent than ever. Its power to stir emotions, provoke thought, and instigate transformation is actually remarkable. This extraordinary book, aptly titled "**Blind Channel Equalization And Identification**," written by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound affect our existence. Throughout this critique, we will delve to the book is central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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