

# Robust beamforming and artificial noise design in interference networks with wireless information and power transfer

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Received: 14 April 2016 / Accepted: 22 September 2016 / Published online: 13 October 2016  
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**Abstract** In this paper, the robust beamforming and artificial noise design is investigated in two-user interference networks with wireless information and power transfer. Specifically, we focus on the secure communication of the two pairs in the presence of an energy receiver (ER) which acts as the potential eavesdropper and intends to wiretap the confidential message transmitted to one of the information receivers (IRs). With only imperfect eavesdropper's channel state information (ECSI) at the transmitters, our goal is to minimize the total transmit power, while guaranteeing the worst-case secrecy rate requirement at the wiretapped IR, the signal-to-interference-plus-noise ratio requirement at the wiretap-free IR and the energy harvesting requirement at the ER. In particular, we first model the imperfect ECSI in the sense of ellipsoidal uncertainties. Then, our design goal can be further reformulated as a two-stage optimization problem. With the help of rank relaxation and one-dimensional line search, the considered two-stage problem can be solved efficiently. Simulation results verify the effectiveness of the proposed design in different scenarios.

**Keywords** Robust beamforming · Artificial noise · Semidefinite program (SDP) · Interference networks · Simultaneous wireless information and power transfer (SWIPT)

## 1 Introduction

Relying on wireless networks for transmission of important information, such as banking related data communications or credit card transactions, the security of wireless network has become a critical issue in wireless applications [1, 2]. Recently, there are growing interests on physical layer security, which can guarantee the perfect secrecy communication from the information-theoretic perspective [3]. The basic idea of physical layer security is to exploit the randomness of wireless channel and signal processing techniques to secure the confidential message transmitted to the intended receiver, while preventing the eavesdropper from wiretapping the information. In particular, the multiple-input multiple-output multiple-eavesdropper wiretap channel in a three nodes scenario is studied in [4, 5], which reveals that having multi-antenna at the transmitter can improve the secrecy performance of the system effectively. Some works focus on dealing with the security issues in wireless sensor networks (WSNs) [6], multiuser networks [7, 8], large-scale multiple-input multiple-output (MIMO) systems [9, 10] and relay networks [11, 12].

Wireless power transfer constitutes an important technique for achieving high energy efficiency promised by green radio. Recently, a significant amount of research effort has been dedicated to wireless power transfer due to the tremendous success of WSNs, which have been widely applied for intelligent transportation, environmental monitoring and

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# Robust Beamforming And Artificial Noise Design In

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*Convergence of Energy, Communication and Computation in B5G Cellular Internet of Things* Xiaoming Chen, Qiao Qi, 2020-04-13 This book focuses on the convergence of energy communication and computation in the beyond 5G B5G cellular Internet of Things IoT It addresses both theory and techniques with more weight placed on the latter This is achieved by providing in depth studies on a number of major topics such as wireless power transfer non orthogonal multiple access massive multiple input multiple output and over air computation In turn four typical convergence scenarios are studied in detail the convergence of energy and communication convergence of energy and computation convergence of communication and computation and convergence of energy communication and computation The comprehensive and systematic coverage of key techniques in the convergence of energy communication and computation in the B5G cellular IoT is one of the book s major features making it particularly well suited for readers who are interested in learning about practical solutions in B5G wireless networks Accordingly the book offers a valuable resource for researchers engineers and graduate students in the fields of information engineering telecommunications engineering computer engineering etc

**Engineering Applications of AI and Swarm Intelligence** Xin-She Yang, 2024-09-25 The book is focused on latest developments and findings on engineering applications of AI and swarm intelligence It provides comprehensive reviews and surveys on implementations and coding aspects of case studies and applications where appropriate The book is useful for scholars lecturers and practitioners from academia and industrial applications The readership of this book also includes Ph D students and researchers with a wide experience in the subject areas

**Wireless Powered Communication Networks** Abbas Jamalipour, Ying Bi, 2018-10-12 This textbook introduces Wireless Powered Communication Networks WPCNs as a promising paradigm to overcome the energy bottleneck suffered by traditional wireless communication networks as well as emerging Internet of Things networks It selectively spans a coherent spectrum of fundamental aspects in WPCNs such as wireless energy transfer WEH techniques radio frequency RF energy harvesting receiver model simultaneous wireless information and power transfer SWIPT as well as the rate energy tradeoff arising from the joint transmission of information and energy using the same waveform It covers network models for WPCNs including the baseline and dual hop WPCN models and a variety of related extensions This book further examines the key factors including throughput fairness and security that must be taken into account for impeccable operation of WPCNs The new IoT applications are targeted as a key element in those factors It will also include exercises and examples throughout the book as well as their PLS solutions This is the first textbook examining the current research to provide a unified view of wireless power transfer WPT and information transmission in WPCNs from a physical layer security PLS perspective Focused on designing efficient secure transmission schemes analyzing energy evolution process and evaluating secrecy outage performance under different channel state information CSI the results presented in this book shed light on how to best balance security and throughput with prudent use of harvested

energy in WCNs It also provides an overview of the WPCNs by introducing the background of WPT followed by a summary of the research conducted in the field The authors describe the physical layer security PLS problem in WPCNs including the causes and the impacts of the problem on the performance of WPCNs The authors extend the discussions by introducing the applications of WPCNs in the IoT From the Internet of Things IoT point of view this textbook reviews the opportunities and challenges for the lately emerged WPCN to seamlessly integrate into the IoT ecosystem It specifically addresses the maximization problem of uplink and downlink sum throughout in a dual hop WPCN while taking fairness among WPCN users as a constraint The results provided in this book reveal valuable insights into improving the design and deployment of future WPCNs in the upcoming IoT environment This textbook targets advanced level students studying wireless communications and research engineers working in this field Industry engineers in mobile device and network development business with an interest in WPCNs and IoT as well as their PLS solutions will also find this book useful

**Intelligent Sensing and Communications for Internet of Everything** Zhengyu Zhu,Zheng Chu,Xingwang Li,2022-01-14 Intelligent Sensing and Communications for Internet of Everything introduces three application scenarios of enhanced mobile broadband eMBB large scale machine connection mMTC and ultra reliable low latency communication URLLC A new communication model namely backscatter communication BackCom intelligent reflector surface IRS and unmanned aerial vehicle UAV technology in Internet of Everything IoE is described in detail Also focusing on millimeter wave the book discusses the potential application of terahertz 6G network spectrum in the Internet of Things IoT Finally the applications of IoE network in big data artificial intelligence AI technology and fog edge computing technology are proposed Systematically introduces the technical standards and market analysis of 5G s three application scenarios as well as the problems and challenges faced Provides readers with the knowledge of spectrum energy efficiency and cost effective IoE network solutions Introduces the application of physical layer related technologies to the IoT such as BackCom IRS and UAV relay in IoE and millimeter wave technology Discusses the potential application of terahertz 6G network spectrum in the IoT

*Handbook on Advancements in Smart Antenna Technologies for Wireless Networks* Sun, Chen,Cheng, Jun,Ohira, Takashi,2008-07-31 Provides information on smart antenna technologies featuring contributions with in depth descriptions of terminologies concepts methods and applications related to smart antennas in various wireless systems

**Signal Processing Approaches to Secure Physical Layer Communications in Multi-Antenna Wireless Systems** Y.-W. Peter Hong,Pang-Chang Lan,C.-C. Jay Kuo,2013-09-30 This book introduces various signal processing approaches to enhance physical layer secrecy in multi antenna wireless systems Wireless physical layer secrecy has attracted much attention in recent years due to the broadcast nature of the wireless medium and its inherent vulnerability to eavesdropping While most articles on physical layer secrecy focus on the information theoretic aspect we focus specifically on the signal processing aspects including beamforming and precoding techniques for data transmission and discriminatory training schemes for channel estimation The discussions will cover cases

with collocated and with distributed antennas i.e. relays The topics covered will be of interest to researchers in the signal processing community as well to practitioners and engineers working in this area This book will also review recent works that apply these signal processing approaches to more advanced wireless systems such as OFDM systems multicell systems cognitive radio multihop networks etc This will draw interest from researchers that wish to pursue the topic further in these new directions This book is divided into three parts i data transmission ii channel estimation and iii advanced applications Even though many works exist in the literature on these topics the approaches and perspectives taken were largely diverse This book provides a more organized and systematic view of these designs and to lay a solid foundation for future work in these areas Moreover by presenting the work from a signal processing perspective this book will also trigger more research interest from the signal processing community and further advance the field of physical layer secrecy along the described directions This book allows readers to gain basic understanding of works on physical layer secrecy knowledge of how signal processing techniques can be applied to this area and the application of these techniques in advanced wireless applications

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## **Table of Contents Robust Beamforming And Artificial Noise Design In**

1. Understanding the eBook Robust Beamforming And Artificial Noise Design In
  - The Rise of Digital Reading Robust Beamforming And Artificial Noise Design In
  - Advantages of eBooks Over Traditional Books
2. Identifying Robust Beamforming And Artificial Noise Design In
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Robust Beamforming And Artificial Noise Design In
  - User-Friendly Interface
4. Exploring eBook Recommendations from Robust Beamforming And Artificial Noise Design In
  - Personalized Recommendations

- Robust Beamforming And Artificial Noise Design In User Reviews and Ratings
- Robust Beamforming And Artificial Noise Design In and Bestseller Lists
- 5. Accessing Robust Beamforming And Artificial Noise Design In Free and Paid eBooks
  - Robust Beamforming And Artificial Noise Design In Public Domain eBooks
  - Robust Beamforming And Artificial Noise Design In eBook Subscription Services
  - Robust Beamforming And Artificial Noise Design In Budget-Friendly Options
- 6. Navigating Robust Beamforming And Artificial Noise Design In eBook Formats
  - ePub, PDF, MOBI, and More
  - Robust Beamforming And Artificial Noise Design In Compatibility with Devices
  - Robust Beamforming And Artificial Noise Design In Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Robust Beamforming And Artificial Noise Design In
  - Highlighting and Note-Taking Robust Beamforming And Artificial Noise Design In
  - Interactive Elements Robust Beamforming And Artificial Noise Design In
- 8. Staying Engaged with Robust Beamforming And Artificial Noise Design In
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Robust Beamforming And Artificial Noise Design In
- 9. Balancing eBooks and Physical Books Robust Beamforming And Artificial Noise Design In
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Robust Beamforming And Artificial Noise Design In
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Robust Beamforming And Artificial Noise Design In
  - Setting Reading Goals Robust Beamforming And Artificial Noise Design In
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Robust Beamforming And Artificial Noise Design In
  - Fact-Checking eBook Content of Robust Beamforming And Artificial Noise Design In

- Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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