Optical Wireless Communications

System and Channel Modelling with MATLAB®

Z. Ghassemlooy

W. Popoola

S. Rajbhandari

Optical Wireless Communications System And Channel Modelling With Matlab

Anirban Bhowal,Rakhesh Singh Kshetrimayum

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Optical Wireless Communications Z. Ghassemlooy,W. Popoola,S. Rajbhandari,2012-08-08 Detailing a systems approach Optical Wireless Communications System and Channel Modelling with MATLAB is a self contained volume that concisely and comprehensively covers the theory and technology of optical wireless communications systems OWC in a way that is suitable for undergraduate and graduate level students as well as researchers and professional engineers Incorporating MATLAB throughout the authors highlight past and current research activities to illustrate optical sources transmitters detectors receivers and other devices used in optical wireless communications They also discuss both indoor and outdoor environments discussing how different factors including various channel models affect system performance and mitigation techniques In addition this book broadly covers crucial aspects of OWC systems Fundamental principles of OWC Devices and systems Modulation techniques and schemes including polarization shift keying Channel models and system performance analysis Emerging visible light communications Terrestrial free space optics communication Use of infrared in indoor OWC One entire chapter explores the emerging field of visible light communications and others describe techniques for using theoretical analysis and simulation to mitigate channel impact on system performance Additional topics include wavelet denoising artificial neural networks and spatial diversity Content also covers different challenges encountered in OWC as well as outlining possible solutions and current research trends A major attraction of the book is the presentation of MATLAB simulations and codes which enable readers to execute extensive simulations and better understand OWC in general

Optical Wireless Communications Z. Ghassemlooy,W. Popoola,S. Rajbhandari,2019-05-02 The 2ndEdition of Optical Wireless Communications System and Channel Modelling with MATLAB with additional new materials is a self contained volume that provides a concise and comprehensive coverage of the theory and technology of optical wireless communication systems OWC The delivery method makes the book appropriate for students studying at undergraduate and graduate levels as well as researchers and professional engineers working in the field of OWC The book gives a detailed description of OWC focusing mainly on the infrared and visible bands for indoor and outdoor applications A major attraction of the book is the inclusion of Matlab codes and simulations results as well as experimental test beds for free space optics and visible light communication systems This valuable resource will aid the readers in understanding the concept carrying out extensive analysis simulations implementation and evaluation of OWC links This 2ndedition is structured into nine compact chapters that cover the main aspects of OWC systems History current state of the art and challenges Fundamental principles Optical source and detector and noise sources Modulation equalization diversity techniques Channel models and system performance analysis Visible light communications Terrestrial free space optics communications Relay based free space optics communications Matlab codes A number of Matlab based simulation codes are included in this 2ndedition to assist the readers in mastering the subject and most importantly to encourage them to write their own simulation codes and enhance

their knowledge implementation and evaluation of OWC links This 2ndedition is structured into nine compact chapters that cover the main aspects of OWC systems History current state of the art and challenges Fundamental principles Optical source and detector and noise sources Modulation equalization diversity techniques Channel models and system performance analysis Visible light communications Terrestrial free space optics communications Relay based free space optics communications Matlab codes A number of Matlab based simulation codes are included in this 2ndedition to assist the readers in mastering the subject and most importantly to encourage them to write their own simulation codes and enhance their knowledge lab codes A number of Matlab based simulation codes are included in this 2ndedition to assist the readers in mastering the subject and most importantly to encourage them to write their own simulation codes and enhance their knowledge *Optical Wireless Communications* Z. Ghassemlooy,W. Popoola,S. Rajbhandari,2017-03-31 Detailing a systems approach Optical Wireless Communications System and Channel Modelling with MATLAB is a self contained volume that concisely and comprehensively covers the theory and technology of optical wireless communications systems OWC in a way that is suitable for undergraduate and graduate level students as well as researchers and professional engineers Incorporating MATLAB throughout the authors highlight past and current research activities to illustrate optical sources transmitters detectors receivers and other devices used in optical wireless communications They also discuss both indoor and outdoor environments discussing how different factors including various channel models affect system performance and mitigation techniques In addition this book broadly covers crucial aspects of OWC systems Fundamental principles of OWC Devices and systems Modulation techniques and schemes including polarization shift keying Channel models and system performance analysis Emerging visible light communications Terrestrial free space optics communication Use of infrared in indoor OWC One entire chapter explores the emerging field of visible light communications and others describe techniques for using theoretical analysis and simulation to mitigate channel impact on system performance Additional topics include wavelet denoising artificial neural networks and spatial diversity Content also covers different challenges encountered in OWC as well as outlining possible solutions and current research trends A major attraction of the book is the presentation of MATLAB simulations and codes which enable readers to execute extensive simulations and better understand OWC in general Optical Wireless Communications Zabih Ghassemlooy,2013 Incorporating MATLAB this book provides a single resource for optical wireless communication systems based on the systems approach It presents past and current research activities to illustrate optical sources transmitters detectors and receivers used in optical wireless communications The text covers both indoor and outdoor environments as well as how different factors including various channel models affect the system performance The authors also discuss the emerging field of visible light communications and describe techniques for mitigating channel impact on the system performance using theoretical analysis and simulation Other topics include hybrid optical and RF wireless systems *Optical Wireless Communications* Zabih Ghassemlooy,W. Popoola,S. Rajbhandari,2018

Optical Wireless Communications Z. Ghassemlooy,W. Popoola,S. Rajbhandari,2017 Detailing a systems approach Optical Wireless Communications System and Channel Modelling with MATLAB is a self contained volume that concisely and comprehensively covers the theory and technology of optical wireless communications systems OWC in a way that is suitable for undergraduate and graduate level students as well as researchers and professional engineers Incorporating MATLAB throughout the authors highlight past and current research activities to illustrate optical sources transmitters detectors receivers and other devices used in optical wireless communications They also discuss both indoor and outdoor environments discussing how different factors including various channel models affect system performance and mitigation techniques In addition this book broadly covers crucial aspects of OWC systems Fundamental principles of OWC Devices and systems Modulation techniques and schemes including polarization shift keying Channel models and system performance analysis Emerging visible light communications Terrestrial free space optics communication Use of infrared in indoor OWC One entire chapter explores the emerging field of visible light communications and others describe techniques for using theoretical analysis and simulation to mitigate channel impact on system performance Additional topics include wavelet denoising artificial neural networks and spatial diversity Content also covers different challenges encountered in OWC as well as outlining possible solutions and current research trends A major attraction of the book is the presentation of MATLAB simulations and codes which enable readers to execute extensive simulations and better understand OWC in general

Advanced Optical and Wireless Communications Systems Ivan B. Djordjevic,2022-06-21 The new edition of this popular textbook keeps its structure introducing the advanced topics of i wireless communications ii free space optical FSO communications iii indoor optical wireless IR communications and iv fiber optics communications but thoroughly updates the content for new technologies and practical applications The author presents fundamental concepts such as propagation principles modulation formats channel coding diversity principles MIMO signal processing multicarrier modulation equalization adaptive modulation and coding detection principles and software defined transmission first describing them and then following up with a detailed look at each particular system The book is self contained and structured to provide straightforward guidance to readers looking to capture fundamentals and gain theoretical and practical knowledge about wireless communications free space optical communications and fiber optics communications all which can be readily applied in studies research and practical applications The textbook is intended for an upper undergraduate or graduate level courses in fiber optics communication wireless communication and free space optical communication problems an appendix with all background material needed and homework problems In the second edition in addition to the existing chapters being updated and problems being inserted one new chapter has been added related to the physical layer security thus covering both security and reliability issues New material on 5G and 6G technologies has been added in corresponding chapters

Optical Wireless Communications Zabih Ghassemlooy,A. C. Boucouvalas,2000   *Green Networking and*

Communications Shafiullah Khan,Jaime Lloret Mauri,2013-10-29 Although the information and communication technology ICT industry accounted for only 2 percent of global greenhouse gas emissions in 2007 the explosive increase in data traffic brought about by a rapidly growing user base of more than a billion wireless subscribers is expected to nearly double that number by 2020 It is clear that now is the ti   6G Mobile Wireless Networks Yulei Wu,Sukhdeep Singh,Tarik Taleb,Abhishek Roy,Harpreet S. Dhillon,Madhan Raj Kanagarathinam,Aloknath De,2021-08-24 This book is the world s first book on 6G Mobile Wireless Networks that aims to provide a comprehensive understanding of key drivers use cases research requirements challenges and open issues that are expected to drive 6G research In this book we have invited world renowned experts from industry and academia to share their thoughts on different aspects of 6G research Specifically this book covers the following topics 6G Use Cases Requirements Metrics and Enabling Technologies PHY Technologies for 6G Wireless Reconfigurable Intelligent Surface for 6G Wireless Networks Millimeter wave and Terahertz Spectrum for 6G Wireless Challenges in Transport Layer for Tbit s Communications High capacity Backhaul Connectivity for 6G Wireless Cloud Native Approach for 6G Wireless Networks Machine Type Communications in 6G Edge Intelligence and Pervasive AI in 6G Blockchain Foundations and Role in 6G Role of Open source Platforms in 6G and Quantum Computing and 6G Wireless The overarching aim of this book is to explore the evolution from current 5G networks towards the future 6G networks from a service air interface and network perspective thereby laying out a vision for 6G networks This book not only discusses the potential 6G use cases requirements metrics and enabling technologies but also discusses the emerging technologies and topics such as 6G PHY technologies reconfigurable intelligent surface millimeter wave and THz communications visible light communications transport layer for Tbit s communications high capacity backhaul connectivity cloud native approach machine type communications edge intelligence and pervasive AI network security and blockchain and the role of open source platform in 6G This book provides a systematic treatment of the state of the art in these emerging topics and their role in supporting a wide variety of verticals in the future As such it provides a comprehensive overview of the expected applications of 6G with a detailed discussion of their requirements and possible enabling technologies This book also outlines the possible challenges and research directions to facilitate the future research and development of 6G mobile wireless networks   Visible Light Communication Suseela Vappangi,Vakamulla Venkata Mani,Mathini Sellathurai,2021-08-10 The field of visible light communication VLC has diverse applications to the end user including streaming audio video high speed data browsing voice over internet and online gaming This comprehensive textbook discusses fundamental aspects research activities and modulation techniques in the field of VLC Visible Light Communication A Comprehensive Theory and Applications with MATLAB discusses topics including line of sight LOS propagation model non line of sight NLOS propagation model carrier less amplitude and phase modulation multiple input multiple output MIMO non linearities of optical sources orthogonal frequency division multiple access non orthogonal multiple access and single carrier frequency

division multiple access in depth Primarily written for senior undergraduate and graduate students in the field of electronics and communication engineering for courses on optical wireless communication and VLC this book Provides up to date literature in the field of VLC Presents MATLAB codes and simulations to help readers understand simulations Discusses applications of VLC in enabling vehicle to vehicle V2V communication Covers topics including radio frequency RF based wireless communications and VLC Presents modulation formats along with the derivations of probability of error expressions pertaining to different variants of optical OFDM   *Indoor Infrared Optical Wireless Communications* Ke Wang,2019-12-23 This book aims to give an overview of recent developments in indoor near infrared optical wireless communication technologies and systems including basic theories operating fundamentals system architectures modelling experimental demonstrations advanced techniques and most recently the research efforts towards integrations Both line of sight and diffusive signals based options will be reviewed to provide readers a complete picture about this rapidly developing area which targets the provision of high speed wireless connectivity to end users in indoor environments such as offices homes and shopping centres to satisfy the growing high speed communication requirement Provides a systematic approach for the fundamentals of indoor optical wireless communications Provides an overview of recent developments in indoor infrared optical wireless communications including theoretical fundamentals Examines system architectures modelling experimental demonstrations and the research efforts towards integrations Dr Ke Wang is an Australian Research Council ARC DECRA Fellow and a senior lecturer in the School of Engineering Royal Melbourne Institute of Technology RMIT University VIC Australia He worked with the University of Melbourne Australia and Stanford University California before joining RMIT University He has published over 110 peer reviewed papers in top journals and leading international conferences including over 20 invited papers He has been awarded several prestigious national and international awards as recognition of research contributions such as the Victoria Fellowship the AIPS Young Tall Poppy Science Award and the Marconi Society Paul Baran Young Scholar Award His major areas of interest include silicon photonics integration opto electronics integrated devices and circuits nanophotonics optical wireless technology for short range applications quasi passive reconfigurable devices and applications and optical interconnects in data centres and high performance computing   Advanced Spatial Modulation Systems Anirban Bhowal,Rakhesh Singh Kshetrimayum,2020-12-12 This state of the art book deals with advanced spatial modulation ASM which are a special class of recent Multiple Input Multiple Output MIMO techniques for various applications like radio frequency RF based body area network BAN communication free space optical FSO communication underwater optical wireless communication UOWC and hybrid FSO RF communication The performance analysis of such systems is achieved in terms of certain performance metrics and compared with other techniques available in the literature Such SM based schemes can find its application in advanced 5G and 6G communications The diagrams of the system models of the different schemes along with tables and examples will help readers get a clear understanding of this approach This book

elucidates required derivations examples and links various concepts related to this field so that readers can gain comprehensive knowledge Pseudo codes or algorithms or MATLAB MATHEMATICA programs are also provided so that readers can easily implement the concepts which they learn This volume will be useful for students researchers and industry alike   **Wireless Communication Systems in Matlab** Mathuranathan Viswanathan,2020-06-08 A learner friendly practical and example driven book Wireless Communication Systems in Matlab gives you a solid background in building simulation models for wireless systems in Matlab This book an essential guide for understanding the basic implementation aspects of a wireless system shows how to simulate and model such a system from scratch The implemented simulation models shown in this book provide an opportunity for an engineer to understand the basic implementation aspects of modeling various building blocks of a wireless communication system It presents the following key topics with the required theoretical background along with the implementation details in the form of Matlab scripts Random variables for simulating probabilistic systems and applications like Jakes filter design and colored noise generation Models for Shannon s channel capacity unconstrained awgn channel binary symmetric channel BSC binary erasure channel BEC constellation constrained capacities and ergodic capacity over fading channel The theory of linear block codes decoding techniques using soft decisions and hard decisions and their performance simulations Monte Carlo simulation for ascertaining performance of digital modulation techniques in AWGN and fading channels Eb N0 Vs BER curves Pulse shaping techniques matched filtering and partial response signaling Design and implementation of linear equalizers zero forcing and MMSE equalizers using them in a communication link and modulation systems with receiver impairments Large scale propagation models like Friis free space model log distance model two ray ground reflection model single knife edge diffraction model Hata Okumura model Essentials of small scale propagation models for wireless channels such as power delay profile Doppler power spectrum Rayleigh and Rice processes Modeling flat fading and frequency selective channels Diversity techniques for multiple antenna systems Alamouti space time coding maximum ratio combining equal gain combining and selection combining Simulation models for direct sequence spread spectrum frequency hopping spread spectrum and OFDM

Wireless Communication Systems in Matlab Mathuranathan Viswanathan,2020-06-08 A learner friendly practical and example driven book Wireless Communication Systems in Matlab gives you a solid background in building simulation models for wireless systems in Matlab This book an essential guide for understanding the basic implementation aspects of a wireless system shows how to simulate and model such a system from scratch The implemented simulation models shown in this book provide an opportunity for an engineer to understand the basic implementation aspects of modeling various building blocks of a wireless communication system It presents the following key topics with the required theoretical background along with the implementation details in the form of Matlab scripts Random variables for simulating probabilistic systems and applications like Jakes filter design and colored noise generation Models for Shannon s channel capacity

unconstrained awgn channel binary symmetric channel BSC binary erasure channel BEC constellation constrained capacities and ergodic capacity over fading channel The theory of linear block codes decoding techniques using soft decisions and hard decisions and their performance simulations Monte Carlo simulation for ascertaining performance of digital modulation techniques in AWGN and fading channels Eb N0 Vs BER curves Pulse shaping techniques matched filtering and partial response signaling Design and implementation of linear equalizers zero forcing and MMSE equalizers using them in a communication link and modulation systems with receiver impairments Large scale propagation models like Friis free space model log distance model two ray ground reflection model single knife edge diffraction model Hata Okumura model Essentials of small scale propagation models for wireless channels such as power delay profile Doppler power spectrum Rayleigh and Rice processes Modeling flat fading and frequency selective channels Diversity techniques for multiple antenna systems Alamouti space time coding maximum ratio combining equal gain combining and selection combining Simulation models for direct sequence spread spectrum frequency hopping spread spectrum and OFDM **Propagation Modeling for Wireless Communications** Indrakshi Dey,2022-05-03 This book introduces the various approaches and tools used for modelling different propagation environments and lays the foundation for developing a unified theoretical framework for future integrated communication networks In the case of each type of network the book uses basic concepts of physics mathematics geometry and probability theory to study the impact of the dimension and shape of the propagation environment and relative transmit receive position on the information flow The book provides an introduction into wireless communication systems and networks and their applications For both systems and networks the basic hard encoder modulator etc and soft components information signal etc are discussed through schematic block diagrams Next each of the modes of communication namely radio waves acoustic waves magnetic induction optical waves biological particles molecules aerosols neural synapse etc and quantum field are discussed For each communication scenario presented the impact of different environmental factors on the propagation phenomenon is articulated followed by different channel modelling deterministic analytical and stochastic techniques that are used to characterize the propagation environment Finally future trends in wireless communication networks are examined and envisioned for next generations 6G 7G of communication systems like space information networks sea to sky internet of vehicles and internet of bio nano things Based on the future trends of integrated networks the book drives the need for a generalized channel model irrespective of the media and mode of information transfer The primary audience for the book is post graduate students researchers and academics in electronics and communications engineering electrical engineering and computer science *Dissertation Abstracts International* ,2008 **Optical Wireless Communications** Murat Uysal,Carlo Capsoni,Zabih Ghassemlooy,Anthony Boucouvalas,Eszter Udvary,2016-08-25 This book focuses on optical wireless communications OWC an emerging technology with huge potential for the provision of pervasive and reliable next generation communications networks It shows how the development of novel

and efficient wireless technologies can contribute to a range of transmission links essential for the heterogeneous networks of the future to support various communications services and traffic patterns with ever increasing demands for higher data transfer rates The book starts with a chapter reviewing the OWC field which explains different sub technologies visible light ultraviolet UV and infrared IR communications and introduces the spectrum of application areas indoor vehicular terrestrial underwater intersatellite deep space etc This provides readers with the necessary background information to understand the specialist material in the main body of the book which is in four parts The first of these deals with propagation modelling and channel characterization of OWC channels at different spectral bands and with different applications The second starts by providing a unified information theoretic treatment of OWC and then discusses advanced physical layer methodologies including but not limited to advanced coding modulation diversity cooperation and multi carrier techniques and the ultimate limitations imposed by practical constraints On top of the physical layer come the upper layer protocols and cross layer designs that are the subject of the third part of the book The last part of the book features a chapter by chapter assessment of selected OWC applications Optical Wireless Communications is a valuable reference guide for academic researchers and practitioners concerned with the future development of the world s communication networks It succinctly but comprehensively presents the latest advances in the field   MIMO-OFDM Wireless Communications with MATLAB Yong Soo Cho,Jaekwon Kim,Won Y. Yang,Chung G. Kang,2010-11-16 MIMO OFDM is a key technology for next generation cellular communications 3GPP LTE Mobile WiMAX IMT Advanced as well as wireless LAN IEEE 802 11a IEEE 802 11n wireless PAN MB OFDM and broadcasting DAB DVB DMB In MIMO OFDM Wireless Communications with MATLAB the authors provide a comprehensive introduction to the theory and practice of wireless channel modeling OFDM and MIMO using MATLAB programs to simulate the various techniques on MIMO OFDM systems One of the only books in the area dedicated to explaining simulation aspects Covers implementation to help cement the key concepts Uses materials that have been classroom tested in numerous universities Provides the analytic solutions and practical examples with downloadable MATLAB codes Simulation examples based on actual industry and research projects Presentation slides with key equations and figures for instructor use MIMO OFDM Wireless Communications with MATLAB is a key text for graduate students in wireless communications Professionals and technicians in wireless communication fields graduate students in signal processing as well as senior undergraduates majoring in wireless communications will find this book a practical introduction to the MIMO OFDM techniques Instructor materials and MATLAB code examples available for download at www wiley com go chomimo

Wireless Communication Systems in MATLAB Mathuranathan Viswanathan,2018-09-07 A learner friendly practical and example driven book Wireless Communication Systems in Matlab gives you a solid background in building simulation models for wireless systems in Matlab This book an essential guide for understanding the basic implementation aspects of a wireless system shows how to simulate and model such a system from scratch The implemented simulation models shown in this book

provide an opportunity for an engineer to understand the basic implementation aspects of modeling various building blocks of a wireless communication system It presents the following key topics with the required theoretical background along with the implementation details in the form of Matlab scripts Random variables for simulating probabilistic systems and applications like Jakes filter design and colored noise generation Models for Shannon s channel capacity unconstrained awgn channel binary symmetric channel BSC binary erasure channel BEC constellation constrained capacities and ergodic capacity over fading channel The theory of linear block codes decoding techniques using soft decisions and hard decisions and their performance simulations Monte Carlo simulation for ascertaining performance of digital modulation techniques in AWGN and fading channels Eb N0 Vs BER curves Pulse shaping techniques matched filtering and partial response signaling Design and implementation of linear equalizers Zero forcing and MMSE equalizers using them in a communication link and modulation systems with receiver impairments Large scale propagation models like Friis free space model log distance model two ray ground reflection model single knife edge diffraction model Hata Okumura model Essentials of small scale propagation models for wireless channels such as power delay profile Doppler power spectrum Rayleigh and Rice processes Modeling flat fading and frequency selective channels Simulation models for Direct sequence spread spectrum frequency hopping spread spectrum and OFDM

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